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DR. C. W. SIEMENS UPON THE DISTRIBUTION OF ELECTRICITY.

In another column will be found an address by Dr. C. W. Siemens, delivered before the Society of Arts, in London, of which body he is Chairman.

This paper may be considered as of more than usual importance for various reasons. It comes from a source of undisputed authority, for few men in our day occupy the commanding position held by Dr. Siemens as regards scientific acquirement, practical information, and, more rare than ever, a combination of both in a business way which has resulted in the accumulation of great wealth; in short, he is most eminently a man of science who has made science pay.

When the subject of renewing his contract for the lighting of a portion of the city of London was under discussion last Spring, he frankly told the authorities that, while others perhaps might be able to afford to advertise their patents at the expense involved in furnishing electric lighting at prices paid previously to that time, he could not; and that the price would have to be increased. In other words, being largely engaged in commercial transactions, he could not see why he should light a part of London, except upon a commercial basis. In the case which he has assumed as a model in his address the Doctor professes to deal with the case in the same spirit; but among the other acquirements in which the Doctor excels most scientific men may be found his skillful use of the English language. It is not his mother tongue, but we must say that few who are born with an English tongue are so skillful in the use of it. The ease with which the plainest and simplest statement is made to cover not only a supposed scientific truth, but a plain practical fact which will result therefrom, has always some exemplifications in an address from Dr. Siemens—and we do not look in vain for such in this address. After clearly stating the amount of light that should be required in a certain district equal to one-quarter of one square mile, and proceeding to deduct therefrom such portions as would not probably be included, or would have a tendency to increase his average too much, he makes an estimate for the expense of the establishment of necessary works, including machinery, engines, distribution, etc., for doing 25 per cent. of the lighting in a district one-quarter of one square mile in extent, at about $885,000—and this includes no house connections or interior fittings.

When speaking of working expenses, the Doctor, with all the ease and quietness of speech imaginable, assumes that his lights are run "six hours a day," and that "with coal at twenty shillings a ton, and a consumption of two pounds of coal per effective horse power per hour," the cost will amount to a certain figure, which is perfectly satisfactory to the Doctor; but any one adopting the standard of cost laid down must closely adhere to the conditions mentioned.

Does the immense establishment of the Siemens Brothers, at Greenwich, obtain all their power of every kind with an expenditure of two pounds of coal per horse power per hour? If so it is very economically managed as to motive power.

And the next matter is gas works. Here, with clearness and simplicity, the Doctor says: "The cost of establishing gas works would not exceed £80,000" ($400,000) as against £177,000 ($885,000) for electricity. Whether the gas works are to supply twenty-five per cent. of the light required, or the whole, is not mentioned. But the main interest is in the conclusions that the Doctor draws from his own comparisons, which are in substance—

That the future of the gas industry bids fair to be a bright one, in spite of electricity. Doctor Siemens, although as familiar as any one else with the capabilities and the possibilities of electricity, has always maintained the doctrine that gas had only good to look for from the introduction of electricity, and he is of the same opinion still; and when he says that incandescent electric lights are a luxury, to be enjoyed, perhaps, by the wealthy, but that gas is the poor man's friend, it certainly does not appear that electric light is to supersede all other forms of artificial lighting on the ground of *price*; and the careful conditions imposed on the calculations above referred to do not look much like a broad margin of profit for those who sell it "as cheap as gas."

SOME OF THE PAPERS READ AT THE PITTSBURGH MEETING.

Now that most of the papers read at the annual meeting of the American Gas Light Association are before our readers, it may be well to touch upon a few of the salient points which those who have had the honor of coming before the Association presented to their listeners. It is not our purpose to

take up the dissertations in the order in which they were presented, nor must the priority we give the papers be taken as index to their importance as they appear to us; for we will consider them simply as the fancy takes us, being guided by no order either of merit, or of position on the programme.

In going back over the proceedings of the Association since its inauguration, it will be found that there are several meetings at which the subject of water gas received a very large share of the time of the Convention. To the list of meetings which are already conspicuous on this account, the last gathering must be added. More especially does it become necessary to assign the Pittsburgh meeting to this category, if we take the paper read by Mr. Fogarty to be what its title claims for it, namely, an account of a new process for manufacturing water gas, because the time taken in the reading and discussion of this dissertation, if added to that devoted to the study of water gas pure and simple—or impure and simple, according to the fancy of our readers—would together represent a very considerable portion of the session. A perusal of the paper alluded to will cause one to doubt if its title is a true exponent of what follows it. But be the title of the paper pertinent or otherwise, none will gainsay that Mr. Fogarty will well deserve a devout and heartfelt blessing from the gas fraternity when he shows them—not on paper alone, but by actual operations carried on on a commercial basis—how gas can be made for seventy-five cents less than nothing. Possibly, we can leave the further consideration of Mr. Fogarty's process until he has reduced it to the basis to which we have alluded, pausing on the present occasion only to remark that, if the inventor does not meet with success, when he attempts to carry out his scheme on a practical footing, he must not be discouraged, but find solace in the fact that, in his disappointment, he has companions; many before having failed to obtain in regular working those results which were so easy of attainment in the laboratory.

If we were not afraid of being accused of showing a disposition to cavil at titles, we would suggest that such a heading as "The Allen-Harris Process versus the Coal Gas Method" would be a little more appropriate as a caption for Mr. Allen's remarks than the title he gave it. We are, however, forced to admit that the titular portion of a paper is of little importance in comparison with the subject matter that follows it. Still, perspicuity on this point would not go amiss, because when the title of a dissertation is announced the listeners naturally outline in their minds the points upon which the remarks will touch; and if the paper does not justify the title chosen it is apt to give rise to some little disappointment—in fact, the listeners are inclined to feel as if a vacuum exists somewhere which must needs be filled. It is perhaps hardly necessary to say that the gas engineers of this country, before their trip to Pittsburgh, were not ignorant of the imperfections of the coal gas process; but it must be borne in mind that this world is made up of imperfections, and there is no reason why we should be exempt on this score. True, we must not rest easy under the doubtful consolations that we are no worse off in this respect than other industries; on the contrary, we must work indefatigably to reduce all the operations of gas making to a point as near perfection as possible.

That bituminous coal, when distilled into oil and then converted into gas produces, theoretically, results superior to those obtained in practical gas making, goes without saying; but again, we say, this is but another illustration of the fact that theory and practice do not always work out to the same point. None, we think, will attempt to controvert the statement that the chemistry of gas manufacture merits the attention of every gas engineer. That the conditions under which coal is carbonized, particularly as regards heat, will have an important influence on the character of the final product, must also go without dispute; but when the author places heat and cold as two forces, one working against the other, he is apt to make his remarks somewhat obscure. For cold cannot be said to be in itself a force at the command of the coal carbonizer. Cold, theoretically, means the absence of heat; in the ordinary acceptation of the word it would indicate such a degree of heat as is indicated by, say, 30° or 40°F. So it is not heat and cold which the gas manufacturer has at his command, but relative degrees of heat. That this is an important matter is patent to all who are familiar with the process of gas manufacture; that certain of the gases in the retort will be converted into a valuable commodity, or a noxious impurity, according to the heat to which they are subjected, is equally well known. And it is greatly to be regretted that we have not more information at our command bearing upon this point.

Nor does Mr. Allen supply the deficiency, but passes on to the consideration of his own process, the details of which our readers are familiar with. Perhaps, when quoting the remarks of gas engineers about the coal gas process being all wrong, it would have been in better form to have stated, in each case, the chapter and verse, and to have given somewhat of the context, so as to show the circumstances under which the remarks were made. Mr. Allen says that coal contains about 81 per cent. of carbon, while the resulting gas can only be credited with 7 per cent., and that the difference between the two figures is wasted in the production of impurities. We fail to see that this is clear. The residuary coke is not generally reckoned as an impurity. Nor can light carbureted hydrogen be so characterized. We have admitted that the coal gas method is not perfect; but we have added the remark that there is nothing in this world that is perfect. Nevertheless, though we have admitted this imperfection, it does not seem to be by any means certain that Mr. Allen's process is an improvement on it.

Few papers give rise to such an extended discussion as ensued when Mr. Pratt's remarks were before the meeting. That the writer, in the main, gave his brethren good advice, none were inclined to deny; that gas companies should endeavor to obtain the moral support of their respective communities also went without saying. How is this support to be obtained? Mr. Pratt says by paying small dividends, while his listeners held that the object would be more easily secured by supplying gas at a low price. For ourselves, we must incline to the latter opinions. Gas companies all over the country have been reducing the price of gas, and generally without affecting their dividends. This good work will doubtless continue to go forward. Possibly, if Mr. Pratt had been better posted in regard to what has been done in this direction, he would not have made such sweeping assertions as some of those contained in his paper.

As long as the risks, which are at present incidental to the gas supply, remain connected with it, gas shareholders will not be content with an eight per cent. dividend; and so long as the managers of such companies take advantage of the improvements which are being made in gas manufacture, we see no reason why the price of the commodity cannot be brought down to a point which will satisfy all but the chronic grumblers, and, at the same time, the returns to the stockholders kept not a high but at a moderate figure.

Cost of Gas and Electricity.

According to the *Journal of Gas Lighting*, at a recent Fine Art and Industrial Exhibition, held at Worcester, England, four-fifths of the area was lighted by gas and one-fifth by electricity, for the period of 105 days, at an average cost, per night, as follows, viz.—

Lighting an area of	44,000 square feet	by gas..... $6.80
" "	10,800 "	by electricity..... $9.52

Reduction of Price of Gas in Boston, Mass.

The Boston Gas Light Company has determined on making a New Year's gift to its consumers, and has given notification, through its secretary, that on and after January first, 1883, the price of its gas shall be $1.80 per thousand. This is the proper and enduring method of securing the "goodwill of the community."

The Pintsch System.

Vice-President and General Manager C. C. Waite, of the Cincinnati, Hamilton and Dayton Railroad lately gave a trial to the Pintsch system of lighting coaches with compressed oil gas. The company interested in the experiment were ably represented by their engineer, Mr. Alex. C. Humphreys, who had forwarded to the place of the test a handsome coach of the Erie road, the Erie Railway Company having already adopted the system. The car, upon which were several prominent railway men, was attached to a train leaving at dark, and moved out a short distance. The contrast between the brilliant interior, in which one could read the finest print in any seat, with that of even the best lighted car in the residue of the train, was marked, although one of these was a Pullman coach, lighted with four double lamps on the most modern and improved plan. It is claimed for the system that including interest on the first outlay of from ten to twenty thousand dollars for the "plant," it is as economical as oil lamps, while as much safer as it is more brilliant, for in case of an accident it would go out at once. The Erie coach in question is fitted with 5 lamps, aggregating 13 burners, consuming about 11½ cubic feet of gas per hour. The supply comes from tanks beneath the car, so fitted with a diaphragm and springs that an even pressure is maintained at all times, with the further aid of a regulator, automatic in its action. The gas is of sixty candle power, and gives its light through the medium of handsome lamps hanging 21 inches each from the roof of the car, with transparent globes below, throwing no shadows of account. A supply for 26 hours is carried, with 150 pounds pressure.

Each lamp can be turned on or off or high or low separately, or all may be regulated at once from the dressing-room, which is also handsomely lighted. The tanks are filled by a valve on either side of the car, the gauge being attached on the other. The Erie, New York, Providence and Boston, the Providence and Stonington steamers and other Eastern lines are using the system. It is asserted that it is cheaper and more practical than electricity has yet proved, Also, that it attains an evenness of pressure not before obtained in gas systems.

[Official Report—Continued from page 258.]

Tenth Annual Meeting of the American Gas Light Association.

Held at the Monongahela House, Pittsburgh, Pa.,
October 18, 19, and 20, 1882.

Second Day—Morning Session—October 19.

The President—We will now resume the consideration of the paper under discussion at the time of the adjournment. Mr. Allen is present, and will answer any inquiries which may be made of him as to his process.

Mr. Pearson—There was one statement made by Mr. Helme which I desire to correct. He said that only between 4,000 and 5,000 feet of water gas per bushel of lime could be purified. In Toronto we purify between 11,000 and 12,000 feet per bushel of lime. I desire to correct another statement which was made by Mr. Helme, and that is that those who are interested in the manufacture of water gas do not give full statements and figures as to cost. I beg to say that two years ago I made a very plain statement, and Mr. Helme himself acknowledged that I had done so.

Mr. Helme—I thought that we had gotten through with the subject of water gas last night. I did not feel that I had anything more to say this morning. The fact is that two years ago Mr. Pearson gave us so much of figures (and of figures of language as well) that I had really forgotten what he had said. I thought he exhausted the subject pretty well, and I had left him out of my eye as being in the water gas business. If I am excusable for doing so, I beg his pardon. As regards this matter of purification, I always speak from my own knowledge of what takes place in Pottsville. There I know it is between 4,000 and 5,000 feet per bushel. Leaving out what Mr. Allen said last evening as to the enormous amount he purified per bushel, Mr. Pearson is the first man I ever heard claim to purify more than 5,000 feet of water gas per bushel of lime. I will not dispute his word; but I still feel that in certain localities we have a very great advantage over oil gas, in making it of good quality from bituminous coal. I do not think I can say anything more to make Mr. Pearson feel comfortable or happy under the circumstances, but I shall be glad to have him suggest what he desires me to say, and I will say it if it is within the bounds of truth.

Mr. Pearson—I only desire to set myself right. If you cannot purify more gas per bushel than you state, it may be the fault of the lime. How do you do it?

Mr. Helme—Mr. Forstall purified, in New Orleans, from 15,000 to 20,000, and we do from 15,000 to 20,000. We do not always get lime from the same kiln, and the variation may be due to that fact. But if we are not getting 15,000 feet to the bushel, somebody hears from us.

Mr. Allen—I desire to be a little better understood than it seems to me I have been on the subject of the use of oil exclusively in our process. I have repeatedly said that where oil is dearer than coal we can use bituminous coal to great advantage. We are not by any means restricted to oil. We commenced with the expectation of using rich bituminous coal; and, as I have already stated, we have probably extracted a greater number of feet from bituminous coal than has ever been extracted by any other process. We are not limited to the use of oil by any means. If oil is cheaper in a place, we propose to use oil; if bituminous coal is cheaper, we propose to use bituminous coal. The engineer in any place will decide for himself with regard to the materials to be used.

Mr. Harbison—The last time I heard Mr. Pearson give us a statement with regard to the water gas process, although it was a very clear and comprehensive statement, and the figures given were the most definite I had then heard with regard to the cost of making gas by that system, yet, as I then understood him to say, the results were not satisfactory to his own mind, and that he had not then been at it long enough to state the results which he hoped to obtain by that process. Possibly he made a supplementary statement the following year which I did not hear and have not read. I would like to know, for my own information, whether he has found his year's experience with the Lowe process entirely satisfactory to himself, and whether he is now making gas exclusively under that process; if not, to what extent is he using it, and what proportion of his whole make is made by the Lowe process, and what proportion by the coal gas process. Or has he absolutely discarded the coal gas process in favor of the Lowe process?

Mr. Forstall—Before Mr. Pearson answers that question I would like to ask him a question. When he speaks of purifying 11,000 cubic feet of gas with one bushel of lime, does he extract all the carbonic acid gas from the gas, as we do from coal gas, or does he merely take out the sulphur compounds? What proportion of the carbonic acid goes out with the gas after purification?

Mr. Price—I would like to inquire whether, as a point of order, we are not departing from the subject under discussion?

The President—Mr. Littlehales has the floor. I suppose Mr. Pearson would prefer to answer all the questions at once having them grouped consecutively.

Mr. Price—Have we got through with the paper by Mr. Allen?

The President—This is a continuation of the subject under consideration last night.

Mr. Littlehales—Before Mr. Pearson replies, I will ask another question, or rather call attention to this fact—that it is not the mere question of putting the gas into the holder, which seems to be made such a great deal of, but it is the question, how does the balance sheet tell at the end of the year which is of such importance. So far as my own experience goes, it is that——

The President—Let me interrupt you Mr. Littlehales, and ask you to wait until Mr. Pearson shall have answered the questions put to him.

Mr. Pearson—The first question asked me was whether we use the Lowe process still. We do; we are making gas entirely by the Lowe process to the utmost capacity of the works which we put in, until the short days render it necessary for us to make coal gas. We have not supplemented our Lowe process works, and do not think it desirable to do so; but we are now manufacturing gas by that process to the very fullest extent. Financially, as I said here in my first and second papers, it depends upon the price of materials. I entirely agree with everything that Mr. Helme said with regard to location having everything to do with whether or not the Lowe process can be profitably used. It depends very largely upon the cost of materials. The prices of materials have been somewhat higher than when the process was first introduced. We are not now deriving quite as much benefit from it financially as we did at first, in consequence of variations in price. The oil which we purchased in the first instance was exceedingly low. We are now paying one-third or one-half more for it than we did at first; but, notwithstanding that fact, there has been a very considerable balance in favor of the Lowe process. Financially, it is a success with us.

Mr. Helme—What do you get per thousand feet?

Mr. Pearson—We charge $1.75 to consumers of under 200,000 cubic feet, and $1.50 to consumers of over that quantity, and $1.50 for gas engines and cooking stoves. A gentleman asks me to state the prices of oil and of coal. We are using what is called "gas oil," costing $1.25 per barrel at Petrolia, and to that the freight is to be added. We pay for hard coal about $5.50. Some years ago we were paying under $5 for coal, and a part of the time we were paying under $1 per barrel for oil. Of course these differences in prices of materials make a difference in the cost of the gas. In speaking of a ton I mean 2,000 pounds.

Mr. Forstall—My question was whether you extract the carbonic acid gas from the gas.

Mr. Pearson—I believe so, but cannot answer with certainty.

Mr. Helme—I wish to say, with regard to the oil process, and especially the Lowe process, that Mr. Marcus Smith said, some time ago, that wherever naphtha costs over 5 cents per gallon, and you can get gas-making bituminous coal at $4 per ton, you had better stick to the coal.

Mr. Pearson—I say that too.

Mr. Helme—I heard him say it a few years ago, and he repeated it last night, and says that he has had no occasion to change his mind. The gentlemen who advocate the making of water and oil gas cannot complain of us unsophisticated coal men for being a little cautious. A case in Norfolk seems to be one in point, where Mr. Allen appears at the present time to be holding the trump card. The case there is this: A few years ago they spent $15,000 or $20,000 in putting in what I think was called the Mackenzie process. They ran along for a considerable length of time, and then it was thrown overboard, and they introduced the Lowe process at an expense of $15,000 or $20,000. That ran along for a few months, and now we find that Mr. Allen has put in the Harris process, and that it is now being tried. It shows that, with all the caution we may exercise with regard to these different things, we are liable to be deceived, and to spend our money for that which we cannot use; and when our money is gone we cannot get it back again. Therefore it becomes us to be cautious in adopting these new methods. Why this change has been made at Norfolk I do not know; but I have understood that the Lowe process has been displaced by the Harris; what will displace the latter it is for the future to discover.

Mr. Littlehales—It is not a mere question of the cost in the holder. So far as my own investigations extend, I have never yet found a single case (when I could get at the true inwardness of the matter) where they were making more profit than can be made by the ordinary coal gas process. I know of some cases where it has been reversed, and where any qualified coal gas man could have done far better under the circumstances. While the retort house labor is undoubtedly less, the other labor is undoubtedly more; but the saving to the regenerator department is infinitely more than counterbalanced by the outside expenses. That has been my experience, and it has been confirmed by very careful inquiry and investigation. I feel confident that that is the true state of the case.

Mr. Allen—I would like to say that I do not think Mr. Littlehales could have gained very correct information upon the subject. Go to the coal gas retort house, and see the men laboring there drawing the charges once in

four hours, working in the great heats to which they are exposed, and the works not turning one-quarter of the materials used into gas; and then come into our works (I speak of ours because I am better acquainted with them, and because I do not wish to make any visionary statement), where the men at work are able to keep cool, and the gas house is kept perfectly clean; where it is no more work to draw a retort than it is to shake up a furnace, and where we draw our retorts but once in seven days; and where we are able to obtain a continuous production of gas. We are the first ones ever to show a continuous stream of hydrogen gas made; and we have kept that up for seven years, and it is going to-day. If our consumption were large enough we could keep that going, and could show better results than we have ever yet been able to show. I cannot conceive why Mr. Littlehales thinks that, outside of the retort house, the labor is so much greater. Our gas goes out almost pure. I have stated what it costs in the holder. The cost of delivery to consumers is exactly the same as the cost of delivering yours—no more nor less. Where the expense is, outside of the retort house, I am unable to see. We have put a 20.51-candle gas into the holder (that is what we have averaged for the last six months) at a cost, under all our disadvantages, of 40.2 cents per thousand feet. Not only that, but, for a year at a time, we have no complaints coming into the office that "last night the gas was poor." Can any of the gentlemen here state that they are making the same record? The time is coming when the question will be between good gas and electricity. It is not merely the question of what you can make out of your residuals; neither is it what it costs per thousand feet, which is of the greatest importance for us to determine. Men will pay their fare on an express train, and they will pay for a parlor car, or for a sleeping berth at night; and they are willing to pay for such luxuries three times as much as they would have to pay on an accommodation freight train. And so I say of gas. If you deliver to your consumers a pure 20-candle gas (and we do not have a trace of carbonic acid, or of ammonia, or of sulphureted hydrogen in our gas), they will be satisfied to pay any reasonable price for it. I assert, as every gentleman ought to know from the figures that I have given, that the expenses can be greatly reduced by an increase in the amount of consumption. It largely depends upon that. Any body knows that he can make a million feet per year at an infinitely less rate than he can make 75,000 feet. Every gentleman can judge of that for himself. From the experience we have had, I believe that by our process we can take the same materials and make a 20-candle gas cheaper than you can make a 17-candle gas in the old way. Our principle has been to take the rich bituminous coal, of which you use only 10 or 20 per cent. in your process, and by our process make 20,000 feet of gas instead of 10,000; and in that way we make a saving in freight and in labor. The main point, however, is that we make a better gas. And, gentlemen, you may say what you please on that subject; I am satisfied that the better gas will pay in the end.

Mr. Littlehales—I will explain why I did not make Mr. Allen an exception to the general rule which I laid down. It was because of his statement yesterday that he made 5 per cent. on $300,000 capital. I think I can show from our balance sheet that we beat him out of his boots.

Mr. Page—I think that for the first time in the history of the competition between coal gas and water gas, there has been a demonstration at Washington, under the oversight, but not under the direction, of our friend George A. McIlhenny, and under the supervision of one of the ablest gas presidents in the country, which will demonstrate whether water gas can be made cheaper and better near a supply of naphtha, and near a supply of bituminous coal, than coal gas can be made. At one end of the retort house the Lowe people have put up the best apparatus which has yet been erected at any point, and have been running it with their own men, in competition with coal gas in the same building. Mr. McIlhenny has nothing to do with the supervision of the water gas process—the Lowe people running that in their own way. The results have not been satisfactory, either in the quality or in the cost of the water gas produced. I am sure that this fact is one of interest to all gas men. Any gas engineer can, by writing to Mr. McIlhenny, have this statement confirmed. I think that one or two of you were present on the same day that I was in Washington, two or three weeks ago. The two processes have been worked side by side, and a demonstration made in a most practical manner.

Mr. Pearson—In speaking of the saving by the Lowe process, I spoke of the gas as delivered to the consumers, and not of the cost in the holder. As compared with coal gas, I can say that we made a considerable saving; and I think it is well worth while to adopt the process. I am speaking, of course, only as to our locality.

Mr. Greenough—Is Mr. Pearson able to control the illuminating power of his gas with the same regularity that he can coal gas?

Mr. Pearson—Just as much so. From the published reports made by the Government, I am able to say that the variations in the Toronto gas are not as great as are the variations in the coal gas made by other companies in the Dominion. I speak from my own observations of a year ago, and from that time backward. I do not know anything about what is being done at the present time. I can say that, from frequent photometric tests, I find very little variation indeed. The gas is tested several times per day, and does not vary over 1½ candles per day.

Mr. Greenough—I asked the question because I had been informed by gentlemen who had been there that the amount of variation was not wholly under control, and that that was one of the troubles attending the use of the process.

Mr. Pearson—I simply speak of what the photometer shows; and I am satisfied that the variation can be controlled just as readily as it can be with coal gas.

Mr. Harbison—I wish a little further information from Mr. Allen with regard to the Allen-Harris process at Poughkeepsie—that being the special matter under consideration. The question which occurs to me is, why, if Mr. Allen has been constantly furnishing gas of the illuminating power of 20½ candles, he has not long ago closed up the works of the Poughkeepsie Gas Light Company, because of the superior illuminating power of the gas which he is giving to the people. If the people will pay an extra price for the privilege of riding on an express train, rather than ride on a freight train, why have not the people been willing to take the 20-candle gas in preference to the 17-candle gas, when both are offered at the same rate per thousand feet? Why has not Mr. Allen's company been able, by reason of the alleged preference of the people for the better gas, to take the business away from the coal gas company, and compel them to close their works? And why is he not furnishing gas to the people of Poughkeepsie at a greatly reduced rate? I wish Mr. Allen would answer that inquiry if he can.

Mr. Allen—I will state that we are now delivering at least two-thirds of the gas that is made in Poughkeepsie. When we commenced there the old company raised the cry that the people did not want but one company; and that two companies would be injurious to the place. They now say that two companies are necessary, and that if we get the monopoly it will be just as bad as it was before. [Laughter.] They judge us by themselves. I think we have done pretty well there. When we commenced there they had been at work for 26 years; yet they had never had but 268 street gas lamps and 237 oil lamps. We are now lighting 576 and have just got ten new lamps, which will be lighted the first of next month. Instead of 237 oil lamps, we have about 60. They have their personal friends and influence. They are now afraid that we shall get the whole of the lighting, and their stock in trade now is the assertion that two companies are needed. They claim that opposition in the business of gas lighting is needed in every place. That is the only reason why we have not got it all. The old gas works are owned by gentlemen who are for the most part independent, and who will not sell out except at what is considered to be an enormous price. Notwithstanding these facts, we have succeeded, in seven years, in getting two-thirds of the gas lighting.

Mr. Harbison—Mr. Allen has not quite answered my questions. It is not what the old companies may think of the desirability of the new process; but why have the people, who pay the gas bills, continued for seven years to support the old gas company, when he has been doing so much better for the people in the quality of his gas than the old company can do? Why have not all of the people taken the express train rather than the freight? Why have they not taken the 20-candle power gas rather than that of 17 candle power? Why has he not been able to establish such a reputation for straightforward, liberal dealing with the people in the seven years as to enable him and his company to secure the unqualified confidence of the people, when he has been demonstrating to them right along, day after day, for seven years, that he can do so much better by them than the old company can possibly do? Why has he not received all of the business, instead of only two-thirds of it?

Mr. Allen—All the people do not ride in parlor cars to-day, although a majority of those who are able to do so do ride in them. I do not say that we can control every man in Poughkeepsie. The gas company has its friends, its stockholders, its capitalits, who stand by them still, although many have told me that they are afraid we will get them all. It is a foolish fear, because we propose, when we do get hold, to put the price of gas down still lower. But you cannot convince a whole community of that. Of course, I do not go around telling how much more honest I am than other people; but I say that has been our policy ever since we commenced the business—putting the price of gas down for the purpose of getting consumers to take it and use it more freely. We reduced the price from $3 to $1.75; and they had to come down also; and we have greatly increased our consumption by putting the price down. My people thought, when we put it down to $1.75, that we were not doing the wise thing; but I was able to show them, by the end of the year, that we had made more money by doing so.

The President—When was this reduction made?

Mr. Allen—Two years ago last autumn.

The President—What percentage of profit were you making before? You

have stated that with the increased advantages you were now able to make a 5 per cent. profit. What were you making before?

Mr. Allen—We have paid 6 per cent.

The President—Then, as I understand it, you were making more before you reduced than you are now.

Mr. Allen—We have laid a great many miles of pipe without increasing our debt.

The President—Then you are doing business on just that much less capital. If you have applied a part of your earnings to increase your plant, you are now estimating profits on a reduced capital.

Mr. Allen—We do not want to increase our capital. It is $250,000, with bonds at $50,000. We are reducing the debt.

The President—But if you take your earnings to apply on account of the capital, then your estimate of earnings must be based upon less capital than your former earnings were based on.

Mr. Allen—I cannot understand you.

The President—Suppose that you had a capital of $300,000, and that you were paying upon that a certain per centage; and that the next year you invest $50,000 in mains. If that expenditure had then been properly charged to the capital account, your capital would then have been $350,000. But suppose you do not charge it to the capital account, but make that investment from the earnings; then you would base your estimate of profits upon $300,000 instead of $350,000.

Mr. Allen—We are making our estimate on $300,000, and pay less dividends than we would if we charged that to the construction account and paid it out of the dividends.

The President—We will imagine that you continue the process that you speak of having followed for the last year; you will ultimately have works worth $1,000,000, with a capital of only $300,000.

Mr. Allen—We have no such anticipation, because Poughkeepsie is too small to make it probable. We accommodate the people from year to year by extending our mains and service pipes. We do it for nothing. Instead of charging the expense to construction account, and increasing our capital we keep our capital at what it was, pay all of these expenses out of the profits, and make our dividends accordingly, and without increasing our debt.

The President—Let me put it in another way. If in other words, you had increased your capital in proportion to your investment, you would now be paying 4 per cent. instead of 5. Is that correct?

Mr. Allen—Yes.

The President—Then if you were making 6 per cent. before, and only 5 per cent. now, without increasing your capital, you cannot be doing as well now as you did before. Is that correct?

Mr. Allen—There are various circumstances operating there. We commenced at $2.70. The old company put their price down to $2.50. We ran for two years without changing our price, letting them have the benefit of the lower price, and taking consumers from them on account of the quality of the gas. Then they came down to $2; and we gave public notice that our price would be $2, and 10 per cent. off. Of course, that reduced the receipts considerably; but the increase in the amount of consumption kept up the profits. Then I had occasion to knock it down to $1.75. When the year ended, we found that we had made a thousand dollars more of net profits during the year it had been $1.75 than we had made the year before at $1.90—thus showing that our reduction had not worked injuriously, as some of our people thought it would, because we had increased our consumption. Our expenses, in the way that I have stated, used up a portion of this profit, and we made a little less dividend than we did at $2.70, because, when we were making dividends at $2.70, we had not gone into these extra expenses. These have grown up since then.

Mr. Vanderpool—I wish to ask a question of Mr. Allen or of Mr. Pearson, with reference to the distribution of the gas—whether either has had trouble from stoppages in the mains or in the burners. An important element connected with the manufacture of water gas has been overlooked, and that is the large percentage of carbonic oxide which is produced by all of these processes, and the numerous accidents which have followed the introduction of water gas. Has Mr. Pearson had any more trouble from accidents in Toronto from the use of this gas?

Mr. Pearson—There have been several fatal accidents in Toronto. Our consumption has vastly increased, and whatever accidents have occurred have been due entirely to the carelessness of people in leaving their burners turned on. There have been several fatal accidents resulting from that neglect. As to the other point, I will say that two years ago we were troubled to a considerable extent from stoppages in the mains from naphtha. We had the naphthaline trouble for about two months last year, and about a week this year. The stoppages were not in the mains, but in the service pipes. We have never had a main closed up since we introduced the Lowe process, but we have had many services stopped just at the change of the seasons. This year we had a stoppage for about a week, but have had none since. Injecting steam into the pipes and purifiers prevents the deposition of naphthaline in the services and mains. We have had no trouble from that source since three years ago.

Mr. Vanderpool—I have heard it stated that in some cases this water gas becomes extinguished at the burner; that the explanation of so many accidents is to be found in the fact of the readiness with which it can be blown out at the burner. I have noticed that in the gas in this building, under high pressure the flame seems to leave the top of the burner, and to become entirely separated from it. I do not know what kind of gas is being distributed here, but I have noticed that tendency at the burner.

Mr. Pearson—I do not think the Lowe gas blows out any more readily than coal gas.

Mr. McElroy—The gas used in this place is made by the Mackenzie process, and contains a large percentage of carbonic oxide.

Mr. Coggshall—There is no question in my mind as to the financial success of water gas; but I would like to ask Mr. Pearson this question: Supposing he has both water gas and coal gas works, but that, because of the increased consumption owing to the low prices and greater business prosperity of the country, he is making gas entirely from coal; could he not put coal gas into the holder cheaper than water gas, taking into consideration the demand for the residual products?

Mr. Pearson—I cannot speak from practical experience, but I do not think so. I know what coal gas formerly cost, but I cannot answer your question definitely as to the present. I am satisfied, from what other gentlemen tell me as to the cost of gas in their places, under circumstances about the same as mine, that we are making gas at a lower rate than they are doing.

The President—What was your send out at the time you were making coal gas?

Mr. Pearson—I cannot speak except from memory, but it was probably 130 or 140 million feet.

The President—What is it at present?

Mr. Pearson—Last year it was 175 millions.

The President—Mr. Coggshall's inquiry is whether you can put that 175 millions into your holder at as cheap a rate as you did the 130 millions.

Mr. Pearson—I do not think we could put 175 millions feet of coal gas into our holder as cheaply as we can the water gas.

The President—The next paper to be presented is that by Mr. Adam Weber, on "Regenerator Furnaces."

REGENERATOR FURNACES.

Mr. Weber—I have not prepared much of a paper. I wish to exhibit to you the lower setting of gas generators of the latest improvements, which came to me only last week, and the drawings of which are before you. I wish to state the number of furnaces which Liegel has at work in this country and abroad:

Germany	126	furnaces,	heating	790	retorts.
England	6	"	"	47	"
France	42	"	"	372	"
Italy	26	"	"	214	"
Austria and Hungary	50	"	"	391	"
Russia	19	"	"	117	"
Sweden and Norway	11	"	"	91	"
Switzerland	9	"	"	66	"
United States	36	"	"	216	"
Total	325	furnaces,	heating	2304	retorts.

Mr. Liegel claims that he can carbonize, with his method of setting, with 11 to 13½ per cent. of the fuel or coal used in heating the furnaces.

The President—By weight or by measure?

Mr. Weber—By weight. He further claims that he can evaporate under his boilers, of the plain cylinder style, 11 pounds of water to 1 pound of fuel, a thing that was never done before. We can evaporate from 8 to 9 pounds under our tubular boilers, but we cannot do it under the plain cylinder boilers. The results claimed by Liegel have never been reached before. There [referring to drawings] is a bench on which I took a patent 10 months ago. It has now been in operation for 8 months for burning and reburning bones for sugar clarification and fertilizing purposes. They burn in one of these retorts 1 ton of bone in 24 hours. I do not see why we cannot burn that much coal. The question is whether the pressure is too great for the retorts.

The President—What is the size of the retort to which you refer?

Mr. Weber—It is 24 x 9 in., and 9 ft. long. It is upright. There [referring to drawings] is the ground plan. There are two series of retorts side by side, with the furnace in the center. We have put 225 pounds of bone in one retort. You see it has a double bottom, so that the coal or bone cannot go clear down to the bottom; there is a false bottom to keep up the materials, so that they will all distill or burn. It has occurred to me why this system of construction could not be applied to the carbonization of coal. The only difficulty presenting itself would be the question as to whether clay retorts could be made that would withstand the pressure caused by the

swelling of the coal—although I think that actual experiments or tests will pave the way toward overcoming that difficulty. Assuming that difficulty to have been mastered, I think this method of carbonizing coal has several advantages over the old method; for instance, economy in floor area, as you build in height, not in width, as with the old benches; increased volume of production in same area, and practicability of erecting suitable apparatus for the converting of the ammoniacal liquor into ammonia salts; the laying of tracks on top of the benches, and the charging of the retorts directly from cars; and the coal stored so that the cars can load through a shute direct from the coal pile, thus obviating entirely the use of the costly mechanical stoker. The economy in labor is also quite a factor in favor of this system as compared with the old bench system. I will explain the plan more fully if desired.

Mr. Starr—Has that furnace been used for the making of gas, or only for burning boneblack?

Mr. Weber—Only for burning boneblack at present.

Mr. Starr—If you were to fill that retort with coal, the coal would swell and would not allow the gas to come out. Has that retort been used here?

Mr. Weber—It has not been used here for making gas; it has been used in Europe with six retorts. As to the swelling of the coal, there is just as much carbon and ammonia in the bone, or more so.

Mr. Forstall—But the bone does not expand as much as the coal.

Mr. Weber—It will expand as much; but in half an hour it will shrink all at once. It will rise up and swell, just as much as the coal, but it will shrink again.

Mr. Allyn—I think that Mr. Weber told me that he had constructed a number of Liegel furnaces at the New York Metropolitan Works. I would like to inquire what result has been obtained there.

Mr. Weber—We have very good results now in the Metropolitan gas works; but we had not at first because we labored under a very great mistake, which was made by the man who was sent out here to construct the furnaces. They gave us the plans as they used them in Europe, as they said; but the statement was totally false. We have now built the benches entirely different from the first plan, and I have brought these plans here for the purpose of showing you the difference between the first structure and the mode of structure in use at present. We found we could not do what was expected. We thought they had not draught enough, and we put on eight feet pipe on top of it; we found that that did worse, because we filled up the flues with carbon, and choked them all up. We found we had to take down our pipe again—that we had too much draught, and that we should only give it a draught equal in speed to about 18 feet per second. That is about the average. We did this and found that our furnaces worked better.

Mr. Allyn—Are they in operation to-day?

Mr. Weber—Yes; they have been out this summer, but will be fired up this winter. We built a series of twenty benches at the same works, of which 10 are operated with Liegel and 10 with Oechelhauser furnaces. We built the structure this year differently from what we did at first. The Liegel furnace is almost universally adopted on the Continent; and Mr. Liegel writes me he is now in negotiation with a London company for the erection of about 26 benches.

Mr. Greenough—I think it very doubtful whether we shall ever adopt the plan of making gas in upright retorts, as suggested by Mr. Weber. The scheme is one which has been frequently brought forward, but it has never yet been put into successful operation. I very much question its feasibility, with the use of the ordinary bituminous swelling coals. I think, as suggested by Mr. Starr, that the swelling would be very likely to cause trouble, and I apprehend that we would also have difficulty in removing the coal tar before it had time to become pitch. But turning from that matter to the question of the introduction of the Liegel furnace, which Mr. Weber has been recommending. I must say that I think there are criticisms to be made on that furnace; and I shall, with great deference to him, doubt his statement as to the general use of the Liegel furnace on the Continent. From the statements which I have received there is another furnace which has some advantages over the Liegel, and is, I should judge, being more largely used. The peculiarity of the Liegel furnace, which distinguishes it from other furnaces, is that it is built underneath the bench and occupies less room. In my opinion there are disadvantages in the construction of a furnace under the bench; and I am also inclined to think that, in order to make the coke run, as is done in the Liegel furnace, you are compelled to subject your furnaces to a higher heat than is advisable to do if you wish to retain the permanent use of the furnace. The cokes which we have in this country are different from those which are in use in Germany and in England, and I question the possibility of using a furnace of that kind in this country without having trouble from it. I question the advisability of the connection between the furnace, under the bed, and the recuperator, which is also under the bed. I am inclined to believe that the furnace should be entirely distinct from the bed. As the gentlemen who were in Boston last year may remember, we have been through very considerable experience in the matter of furnaces. As to the possibility of using American coke and heating up a bench of retorts with ten per cent. of the weight of the quantity of coal used, I should want to see the thing in practical operation, before I can believe in the possibility of its being done. I do not think that anybody has done that in this or any other country, even with foreign coke.

Mr. Weber—We know from experience what our West Virginia and Pennsylvania coals contain, and we had Professor Endemann give us an analysis of what the coke contains. He reported—76.62 per cent. of carbon, 4.28 per cent. of iron, 2.62 per cent. of alumina, 8.68 per cent. of silica, considerable lime, and some other ingredients which I cannot remember. There is no trouble at all, even if we throw a shell or two in the furnaces. The first furnaces which we built in the Metropolitan gas works, in 1879, stood for three years, and were only torn out this last summer to make place for a section. In the course of time, we can tell how we shall succeed in the construction we are now using.

The President—Mr. William Farmer, of New York, is the patentee of an upright retort or cupola, constructed for the purpose of making gas somewhat in the manner suggested. An experimental cupola was built at Baltimore, but with what result I do not know. If he is not present we will pass that feature of the case at present.

Mr. Allyn—I hardly think that the information which I sought for has been given by Mr. Weber. I enquired of him what results had been actually obtained at the Metropolitan works. If the setting has been so universally adopted on the Continent, why did the same setting, constructed from their drawings prove, as Mr. Weber says that it did, almost a complete failure at the Metropolitan gas works in New York.

Mr. Weber—I do not say it was a complete failure after we had remedied it. The first was a failure because of the construction. The furnaces built in Europe, as you can see from these drawings, are quite flat at the bottom.

The President—As I understand Mr. Weber, he attributes the failure at the Metropolitan works to the fact that the furnaces as constructed, being flat at the bottom and flaring continuously from the bottom to the top, did not allow sufficient space for the flux to pass down and out, but it collected in the corners of the furnace and created a solid mass of flux. He has now remedied that by sloping the sides of the furnace gradually from the slot up to the middle of the furnace. If the flux does not run freely with this construction he remedies it by throwing in some lime.

Mr. Weber—These drawings are all made by Liegel, but we could not construct a successful furnace according to them. We had to remodel them according to the fuel we used.

The President—The query propounded by Mr. Allyn is, why a furnace built as those are built succeded abroad and will not succeed here.

Mr. Weber—It is a success here after the alteration is made.

The President—But why will not the same furnace—that is, one built without any alteration—succeed as well in this as in the old country?

Mr. Weber—Because the coke of England and Germany fluxes more easliy—it runs just as tar does on a roof. The coke in this country will not flux unless you add lime to it. When you add lime it runs all right.

Mr. Weber, Jr.—I would like to answer the question Mr. Allyn has asked more fully. In the Metropolitan works they carbonize from 300 to 325 lbs. coal every four hours with the new furnace. The retorts are $15'' \times 23'' \times 9'6''$. The percentage of coke used is about 15 per cent. of the coal carbonized—according to the German method of calculation.

Mr. Nettleton—That is, 15 lbs. to every 100 lbs. of coal carbonized.

Mr. Weber, Jr.—Yes, sir; the difficulties which were first experienced arose because of the difference in the coke. All of the coke would not run. They remedied that by the use of auxiliary grate bars. That allows the coke to drop down slowly, and prevents clinkering; the top layer of the coke always remains in a fusible state, thus facilitating the run. It has been found that little or no stoppage resulted from their use, thus proving their advantage. This was in the early stage of the trial furnaces; now we have found other ways.

Mr. Weber, Sr.—We have adopted another change. We put in, under the slot, these doors, with openings in them for air, admitting only as much air as is necessary for perfect combustion. The air had previous to this change been admitted too freely, and caused a cooling down of the fire slot. There is an opening four inches square, which is opened about two inches, and which admits sufficient air for the purpose. You will also notice here, on both sides of the furnace, small doors, with an opening in each, admitting a supply of air regulated at will, which is heated by the spent heat from the furnace, and carried through heated flues up to the combustion chamber.

Mr. Burtis—We made a test of one of those furnaces in Chicago—not of the full depth, but of half the depth. We were not able to get down the full depth, in consequence of water. From the experiments which we made, we found that when it reached the fusing or fluxing point, the fuel went with the flux. We could not get anything that would stand the heat, and free itself. We have a secondary fire underneath, to prevent it from fusing. We found, the first time we put it in, that it would not stand the heat. We had

o relieve the furnace, and in every instance it carried it away when the flux was ready to pass out. The tiles melted away like tallow before a fire; we were not able to use it at all, and had to abandon it.

Mr. Weber—Will you allow me to ask why you did that?

Mr. Burtis—Because it was not able to stand the heat,

Mr. Weber—No; that was not the reason. Your furnace was too flat; and you had not the necessary height. If you had admitted less air you would not have had the melting down of the furnace. But you had all the heat in one compact mass; you admitted too much air; and you had nothing but the very commonest of common furnaces. That is the reason that you melted down everything. I guarantee that all those furnaces that we put in will last for five years.

Mr. Burtis—If you will let us pay you at the end of the five years, you may send us some of the furnaces.

Mr. Weber—If you will put them up as I direct you, they will last.

Mr. Burtis—We followed the plan that was laid down just as nearly as possible in every respect. It was constructed strictly according to the required measurements, in feet, inches and fractions. We had no occasion to deviate from them, and we followed the directions strictly. I do not know that it will prove a failure in every case; but it did prove a failure with us.

Mr. Littlehales—Had you been using lime in that furnace?

Mr. Burtis—No; it was an entirely new furnace.

Mr. Weber—What kind of a furnace was it that you had?

Mr. Burtis—It was a furnace with a narrow slot, 1½ inches at the bottom, built on the plan of the Liegel furnace, as shown in the London *Journal*.

Mr. Weber—Your furnace was a failure because you had not the necessary depth. You must have at least 54 inches of storage room for your fuel, either of coal or of coke.

Mr. Wood—I have had a little experience with the Liegel furnace. We had no trouble of the kind Mr. Burtis speaks of. We have used the furnace for over a year, and it is in as good order to-day as when it was first fired. We have had fair results from it. I do not know that there is any saving of fuel; but we have a better heat, and we burn off more coal than with the ordinary furnace, with the same amount of coke. The heat is very uniform. So far as we can judge, the furnace will be quite durable. It had the narrow slot which has been spoken of. That did not slip the flux very well. We remedied that by the introduction of a small quantity of steam beneath, and after doing that we had no trouble with the filling up.

Mr. Harbison—Mr. Wood says that there is no saving in the consumption of fuel; but that he carbonizes more coal. Does not that make a saving of fuel? What percentage of increase is there in the amount carbonized?

Mr. Wood—I cannot give the figures.

Mr. Allyn—How much coal did you succeed in carbonizing?

Mr. Wood—The retorts are 9 × 12 × 24. The benches are 6 × 6. They are narrow benches. We put in hour charges; and in four hours burn from 1,600 to 1,800 lbs. of coal per bench.

Mr. Littlehales—Taking into consideration the extra cost of that bench, and its extra production, would you consider it more economical than the old system; and would you be inclined to carry it further than you have, and to adopt it generally?

Mr. Wood—I think not. I do not think that I would fit it up and use it in that way. I should prefer a full furnace of that or some other kind. I do not think that the saving is enough to warrant the filling up of the house with that half furnace.

Mr. Littlehales—Are you sufficiently well satisfied with it to extend it any further, or would you restrict it to its present use?

Mr. Wood—I think, from my experience with it, and from what I can learn from observations made elsewhere, that it promises very great results.

Mr. Harbison—From your experience thus far with half-furnaces, will you be disposed to try the full-sized furnaces, as recommended by Mr. Weber?

Mr. Wood—I have not looked over his latest plans, and cannot say.

Mr. Greenough—We have had some experience in the matter of regenerator furnaces; and the further we have gone the more we have experienced and overcome various difficulties. We are still in an experimental condition. The first furnaces that we put in were built on the Dieterich system. As to the possibility of getting sufficient heat, I think that nobody who has used anything of that kind will find much difficulty in getting what heat he wants. In our retorts we worked off about 300 lbs. of coal in every three hours, without the least difficulty. But we had the pleasure of going through all the subsequent difficulties, of pitch in the mains, stoppages in the pipes, and the melting down of furnaces and of arches, which might be expected from the use of such a heat as that. In fact, we were then so much discouraged that we then started on an entirely different track to obtain a furnace in which we could control the heat, or to which the heat could not get to any such carbonizing point as that. After a good deal of experimenting we have succeeded in getting that furnace. The company with which I am connected are not looking for furnaces which will work off 300 lbs. of coal in three hours. We do not want such a furnace; although we have worked off 300 lbs. in three hours. As a question was asked by some gentleman as to the quantity of coal that could be worked off, I have alluded to that fact in reply. There is no difficulty in any of these generator furnaces in getting any degree of heat you like, provided the furnace is air-tight. It must be air-tight, if you wish to get any valuable result, either in the burning of the coke, or in the standing of the furnace. A year ago we were putting up a double furnace under Mr. Oechelhauser's plan, in the rear of the stack that we were then building. We found that it was impossible to work them satisfactorily because we could not get a draught through the coke. At least we concluded that that was the difficulty. We proceeded then to experiment on a small furnace on the rear of the stack, and with a depth of coke about 4½ feet. It was filled from the top with cold coke, leaving the floor in front perfectly cool, and sending the gases as they came in towards the the front of the fire. That furnace proved such an entire success that we have since built three, and are now charging four furnaces in line in the rear of our stack from a little car which runs over them. Instead of getting the white heat which is seen in most furnaces, the top of the furnace is perfectly cool. There is no apparent wear in the furnace yet, although it has been used for a number of months. The coke is cool on top. You can look in at the front and see all the particles of coke distinctly. The carbonic oxide comes in freely; and you can see the air puffing out in just the small quantity necessary to complete combustion. We are perfectly satisfied with these furnaces, and the retorts are apparently in good condition. We have no steam about them. We use a simple grate furnace. Our coke is so full of clinker that it is much less trouble to handle it in the ordinary grate furnaces than it is with these slots. I am inclined to believe that a furnace constructed in that way is the best method of heating retorts which we have yet found. We are working in one bed—300 lbs. of coal per retort in four hours, giving us 9,000 feet to the retort in 24 hours. We may find it possible hereafter to work off more coal, but we are not desirous of doing so at the present time. Occasionally the fire gets so hot that we feel afraid of pitch, and then we let in extra air through the side flue at the bottom and cool the fire down. The gases show very fair work. Occasionally they show almost perfect combustion. I shall be glad to show these furnaces to any gentlemen who is contemplating a change. Last year we were not satisfied to show anything as we were not then satisfied with their working; but now we do consider that we have a very satisfactory system for heating a bench of sixes. There are no patents on these furnaces, that I am aware of, and any one can construct the furnaces if he sees fit.

Mr. Harbison—How is the consumption of coke?

Mr. Greenough—The consumption of coke is about one-third. Those furnaces are sixes; we are of opinion that furnaces of eights would use practically the same amount of coke as the sixes do. We have been trying one or two experiments with heating eights, but have not yet been successful. I think that we shall finally be able to overcome the difficulties. I was told last year by Mr. Oechelhauser that one of the chief economies which they found in the use of that furnace was gained by putting in the furnace in the rear. They could thus get more retort room, and with the same amount of coke they were able to work off more coal.

Mr. Starr—Will you describe the construction of your furnace again?

Mr. Greenough—It is a furnace which is perfectly straight up and down on all sides. I think that the width of the furnace at the widest part is about 14 inches. It is about three feet long. It rakes back a little in front, and goes up by steps in the rear to an inclined plane, going up between the retorts. The gases meet the air very nearly at the front. We have made analysis of the gases in various parts of the fire. The furnace must be carefully adjusted, and in order to get a satisfactory working there must be a high draft on the fire. The depth of the furnace is about 4½ feet.

Mr. Starr—Is the coke on top of the grate bars about four feet deep?

Mr. Greenough—It would be deeper than that when first filled. We never expect to get it much less than that.

Mr. Littlehales—The object of that I suppose is to secure perfect production of the carbonic oxide?

Mr. Greenough—Yes. If you have perfect production of carbonic acid gas in the furnace you will burn up your furnace. Keeping the furnace cool shows the production of the carbonic oxide. Although our analyses have shown different results, we find that the gases coming from the furnace do not contain over 2½ to 3 per cent. of carbonic oxide. Ordinarily there is 5 or 6 per cent. of free oxygen after the combustion has taken place.

Mr. Starr—Do you use grate bars?

Mr. Greenough—Yes; of the same width as the furnace.

Mr. Starr—Do you let your fire burn out, and drop your bars out to clinker?

Mr. Greenough—No; we put secondary bars above. We find it necessary to work with a high draught; and we find that, with the four fires that we now have, the one next to the chimney gives the best results, and the second nearest the next best result. I have no doubt that these furnaces will work wherever there is a high draught. Our chimney is about 20 inches square, and about fifty feet high.

Mr. Forstall—Do you use the regenerator principle?

Mr. Greenough—No. The air is not taken into these furnaces on the plan that I would adopt if I were to construct them over again. We found in constructing this furnace that we should have to use the heat of the furnace in heating the air. In other furnaces we are trying to heat the air from the bottom flue; and I have no doubt that is satisfactory enough, without going to the expense of putting in all of the recuperator system, which so many of the foreign furnaces use. If you pass the air back and forth underneath the outer flue, the air will enter the combustion chamber sufficiently hot. In the furnaces that we are now using we have passed the air in and around the furnaces in the same way that Dieterich does, introducing it at the bottom, and passing it up the side into the combustion chamber. The air arrives at the point of combustion at a pretty high temperature. I do not look on the saving of coke as of so great moment as the increased production of the mouthpiece and the regularity of the heat; and the posibility of securing regularity of heat without depending upon the skill of the individual fireman. All that the man who takes care of the furnaces has to do is to dump the coke into the top of the furnace as often as is required. All the regulation of the introduction of the air is done by some overseer instead of a fireman who may be careless sometimes and let the heat get down too low, and then find it difficult to get it up again. We can make more gas per retort, we can make it last longer, we can make the heat more regular, and we can make a saving of coke; and those are my arguments in favor of the furnace.

Mr. Starr—Have you abandoned the use of coke at a red heat?

Mr. Greenough—Yes; we do that because the furnaces got so excessively hot that it melted down inside at first. We had so much trouble from that that we preferred to use the coke cold.

Mr. Allyn—Do you feed the fuel to this furnace regularly?

Mr. Greenough—A man can tell pretty nearly how long it takes to burn down; and my impression is that he puts in a little coke every two or three hours.

Mr. Anderson—I built some furnaces at Jamestown, N. Y., last summer, very much upon the plan of the Liegel furnace. The furnace is 4′ 3″ long, 4′ 6″ high, 1′ 4″ wide, running down to an opening in the bottom through the lower arch, of 2′ 6″ long and 2″ wide. It has hot air flues and chambers, with four openings over the fire on each side. The air passages are constructed with a view to tightness, and they form a chamber behind the furnace, so as to permit of the thorough heating of the air. The air is let in over the fire, and the combustion is almost perfect. Looking into the bench in the day time you cannot see a particle of "set." The heat is perfectly white. The result as reported to me by the managing owner is that from benches of five retorts, 13″x24″x9′ they obtain 44,900 feet of gas per bench in one day. On the day that I was there they obtained about 9,000 cubic feet per retort. The ovens are 7′ 4″ wide; with bridge wall settings. We built a number of benches for the Hartford Company partly on that plan, but made them a little different. The air passages were put in the same way, but I used a wide bar at the bottom of the furnace, on each side, 1½x4½ wide, and of the usual size at the centre. This excluded a large part of the air that is taken up through the ordinary furnace. In those benches a very high heat is claimed. Last year I built a set at Lynchburg, Va. The fear was entertained that the heat would burn down the benches, but it did not. A great deal depends upon the material. I think the most satisfactory furnace is the one at Jamestown; and some benches have been built at Somerville during the Summer. During the past few years, I have put in smaller furnaces in a number of works, which are suited to almost any ordinary ovens, being 2′ and upward in height, 14″ to 16″ wide and 4′ to 5′ in length, according to the size of the ovens; having hot air flues and chambers, and two grate bars, 4″ wide, with a smaller 1½″ bar between.

Mr. Greenough—We would like to hear the experience of the President in the use of the Liegel furnace.

The President—We are not using the Liegel furnace, nor anything which can properly be called the counterpart of that furnace. It is a furnace in shape very much like that which Mr. Weber has described as his improvement on the Liegel—with a tapering bottom, running to the slot. The furnace is fed by the hot coke, drawn from the centre retorts and falling down through a shute, by gravity, into the furnace. In the first furnaces built we had only a slot or opening of two inches, and the clinker was softened by steam. They were satisfactory, except that in the course of time by the expansion of the material the tendency of the furnace was to close at the top, and the vent space would become too restricted. We enlarged that, and at the same time enlarged the bottom, putting in two grate bars instead of the slot. That did remarkably well. We then thought to improve on that, and enlarged the flat surface at the bottom to six bars. We found that that gave us an excess of heat. Our object in starting was to obtain the greatest possible heat. We found, however, in a very short time, that we were getting more heat than we could utilize or control. The result was detrimental to the retorts and furnaces, with increase of stopped standpipes and even stopped take-off pipes. We have now gone back on our desire to secure intense heats, and seek a more moderate heat. The benches which we will adopt in our new works will have not to exceed three bars at the bottom, but otherwise, as to the furnaces, be constructed substantially according to Mr. Weber's recommendations. We attempted to improve on the plan by heating the air before it passed into the furnace, but our experiment convinced us that we did not get a corresponding advantage. We intend feeding the new furnaces with moderately heated air, passing into the bench at the bottom, into a chamber built between the front and rear of the furnace, and going from there up to the sides of the furnace, and then fed by openings into the furnace.

Mr. Starr—What depth of grate bar do you use?

The President—The furnace is three feet in depth. We have been using six bars, but now propose to go back to two.

Mr. Pearson—What weight of coke do you get per 100 pounds?

The President—I am not able to answer that question. We are running from 33 to 35 per cent. of coke. We preserve the measurement, but I am not able to speak from memory. The variation as to fuel was not great. It would run from 33 to 40 per cent. of the coke made.

Mr. Pearson—We have not had much experience with the regenerator furnace, but we have been experimenting for the past two years; and our experience has been precisely like that of the President. We commenced with a 2-inch slot, then we used a 6-inch, and finally settled down to two or three bars, and have thus got the best results. For three months the three benches averaged 16 pounds of coke per 100 pounds of coal carbonized. But we had a great deal of trouble with stopped standpipes, and with pitch in the mains, and we have now reduced our heat as much as possible. I think there is no doubt that the regenerator furnace is the best that can possibly be adopted, not only because of the saving of fuel, but also because of the saving of labor and because of the greater uniformity in the quality of gas which is secured by its use. I think that any works running one bench of retorts can afford to put in a regenerator furnace. There is no necessity for paying any royalty on the patents; the principle is free to all, and any man can put in his own regenerator.

There is no doubt great economy in the saving of labor attending the use of that furnace. You are able to dispense with all the expensive and wearing labor of clinkering, which is inseparable from the use of the old furnace. One man can attend to 12 or 16 of these furnaces. I am speaking now of the furnace we are using. It requires very little attention—simply a shaking up of the ashes, and once in three days the removal of a portion of the clinkers that may adhere to the side. The economy is largely in the labor attending its care.

Mr. Wood—Is the draught directly underneath?

The President—Yes, sir.

Mr. Wood—How deep is the furnace?

The President—I think the furnace is about 6 feet in depth.

Mr. Weber—I would differ with you, Mr. President, in saying that you would not heat up to the full extent in order to get the highest degree of heated air. If I could get 2,200 or 2,300 degrees of heat, I would rather have it. I would reduce the amount of coke used, and I would reduce the speed of the furnace, so that it will not cut. When you have a steady heat, going slowly, you can carry that heat up to 2,300° or 2,500° without detriment. But the moment you get a high speed of heat it cuts away. You must allow, in the gas generating furnace, much more space between the retorts than you do with the others. I would rather have the space outside of the retorts, by the down draught, 6 inches than 4. In some country places, and even in some cities, the space of the down draught is reduced to 2 inches. That is entirely wrong. Give all the space you can to the gas generator furnace, and by this means you will obtain greater durability of the retorts and settings.

The President—What, in your judgment, is the effect of feeding different qualities of air into the furnace? What difference is there between taking perfectly pure air from outside of the retort house and conducting it to the furnace, and air taken from the cellar of the retort house, or from a mass of smoke and steam?

Mr. Weber—I would much prefer taking it from the outside, by bringing it in through a canal or pipe, shutting out all of the steam and smoke.

The President—That would of course increase the expense.

Mr. Weber—Of course it would add the cost of making the box or pipe.

[To be continued.]

Burning Gas without Flame.

Mr. Fletcher, of Warrington, England, a gentleman widely known to gas men in Europe, at a meeting of the Society of Chemical Industry, held at Owen's College, demonstrated the possibility of the combustion of gas without visible flame, the heat obtained from a quarter inch gas pipe being sufficient to fuse iron into drops. The experiment excited a great deal of interest.

[From the "Journal of the Society of Arts."]

The Cost of Electric Lighting.

At the First Ordinary Meeting of the Society of Arts, held on Wednesday, November 15th, 1882, Charles William Siemens, D.C.L., LL.D., F.R.S., Chairman of the Council, delivered the following address:

Having received the honor of being elected Chairman of the Society of Arts for the ensuing year, the duty devolves upon me of opening the coming session with some introductory remarks:

Only a few months have elapsed since I was called upon to deliver a presidential address to the British Association at Southampton, and it may be reasonably supposed that I then exhausted my stock of accumulated thought and observation regarding the present development of science, both abstract and applied; that, in fact, I come before you, to use a popular phrase, pretty well pumped dry. And yet, so large is the field of modern science and industry, that, notwithstanding the good opportunity given me at Southampton, I could then do only scanty justice to comparatively few of the branches of modern progress, and had to curtail, or entirely omit, reference to others, upon which I should otherwise have wished to dwell.

There is this essential difference between the British Association and the Society of Arts, that the former can only take an annual survey of the progress of science, and must then confide to individuals, or to committees, specific inquiries, to be reported upon to the different sections at subsequent meetings; whereas the Society of Arts, with its 3,450 permanent members, its 95 associated societies, spread throughout the length and breadth of the country, its permanent building, its well-conducted *Journal*, its almost daily meetings and lectures, extending over six months of the year, possesses exceptionally favorable opportunities of following up questions of industrial progress to the point of their practical accomplishment.

In glancing back upon its history during the 128 years of its existence, we discover that the Society of Arts was the first institution to introduce science into the industrial arts; it was through the Society of Arts and its illustrious past-president, the late Prince Consort, that the first Universal Exhibition was proposed, and brought to a successful issue in 1851; and it was due to the same Society, supported on all important occasions by its present president, the Prince of Wales, that so many important changes in our educational and industrial institutions have been inaugurated, too numerous to be referred to specifically on the present occasion.

Amongst the practical questions that now chiefly occupy public attention are those of electric lighting, and of the transmission of force by electricity. These together form a subject which has occupied my attention and that of my brothers for a great number of years, and upon which I may consequently be expected to dwell on the present occasion, considering that at Southampton I could deal only with some purely scientific considerations involved in this important subject.

I need hardly remind you that electric lighting, viewed as a physical experiment, has been known to us since the early part of the present century, and that many attempts have from time to time been made to promote its application. Two principal difficulties have stood in the way of its practical introduction—viz., the great cost of producing an electric current so long as chemical means had to be resorted to, and the mechanical difficulty of constructing electric lamps capable of sustaining, with steadiness, prolonged effects.

The dynamo machine, which enables us to convert mechanical into electrical force, purely and simply, has very effectually disposed of the former difficulty, inasmuch as a properly conceived and well constructed machine of this character converts more than 90 per cent. of the mechanical force imparted to it into electricity, 90 per cent. again of which may be converted into mechanical force at a moderate distance. The margin of loss, therefore, does not exceed 20 per cent., excluding purely mechanical losses; and this is quite capable of being further reduced to some extent by improved modes of construction. But it results from these figures that no great step in advance can be looked for in this direction. The dynamo machine presents the great advantage of simplicity over steam or other power-transmitting engines; it has but one working part, namely, a shaft, which, revolving in a pair of bearings, carries a coil or coils of wire admitting of perfect balancing. Frictional resistance is thus reduced to an absolute minimum, and no allowance has to be made for loss by condensation, or badly fitting pistons, stuffing boxes, or valves, or for the jerking action due to oscillating weights. The materials composing the machine, namely, soft iron and copper wire, undergo no deterioration or change by continuous working, and the depreciation of value is therefore a minimum, except where currents of exceptionally high potential are used, which appear to render the copper wire brittle.

The essential points to be attended to in the conception of the dynamo machine are the prevention of induced currents in the iron, and the placing of the wire in such a position as to make the whole of it effective for the production of outward current. These principles, which have been clearly established by the labors of comparatively few workers in applied science, admit of being carried out in an almost infinite variety of constructive forms, for each of which may be claimed some real or imaginary merits regarding questions of convenience or cost of production.

For many years after the principles involved in the construction of dynamo machines had been made known, little general interest was manifested in their favor, and few were the forms of construction offered for public use. The essential feature involved in the dynamo machine, the Siemens armature (1856), the Pacinotti ring (1861), and the self-exciting principle (1867), were published by their authors for the pure scientific interest attached to them, without being made subject matter of letters patent, which circumstance appears to have had the contrary effect of what might have been expected, in that it has retarded the introduction of this class of electrical machine, because no person or firm had a sufficient commercial interest to undertake the large expenditure which must necessarily be incurred in reducing a first conception into a practical shape. Great credit is due to Monsieur Gramme for taking the initiative in the practical introduction of dynamo machines embodying those principles; but when, five years ago, I ventured to predict for the dynamo-electric current a great practical future, as a means of transmitting power to a distance, those views were still looked upon as more or less chimerical. A few striking examples of what could be practically effected by the dynamo-electric current, such as the illumination of the Place de l'Opera, Paris, the occasional exhibition of powerful arc lights, and their adoption for military and lighthouse purposes, but especially the gradual accomplishment of the much desired lamp by incandescence in vacuum, gave rise to a somewhat sudden reversion of public feeling; and you may remember the scare at the Stock Exchange, affecting the value of gas shares, which ensued in 1878, when the accomplishment of the subdivision of the electric light by incandescence was first announced, somewhat prematurely, through the Atlantic cable.

From this time forward electric lighting has been attracting more and more public attention, until the brilliant displays at the exhibition of Paris, and at the Crystal Palace last year, served to excite public interest to an extraordinary degree. New companies for the purpose of introducing electric light and power have been announced almost daily, whose claims to public attention as investments were based in some cases upon only very slight modifications of well-known forms of dynamo machines, of arc regulators, or of incandescent carbon lights, the merits of which rested rather upon anticipations than upon any scientific or practical proof. These arrangements were supposed to be of such superlative merit that gas and other illuminants must soon be matters simply of history, and hence arose great speculative excitement. It must be borne in mind, however, that any great technical advance is necessarily the work of time and serious labor, and that when accomplished it is generally found that, so far from injuring industries, it calls additional ones into existence, to supply new demands, and thus gives rise to an increase in the sum total of our resources. It is therefore reasonable to expect that, side by side with the introduction of the new illuminant, gas lighting will go on improving and extending, although the advantage of electric light for many applications, such as the lighting of public halls and warehouses, of our drawing rooms and dining rooms, our passenger steamers, our docks and harbors, are so evident that its advent may be looked upon as a matter of certainty.

Our legislature has not been slow in recognizing the importance of the new illuminant. In 1879 a select committee of the House of Commons instituted a careful inquiry into its nature and probable cost, with a view to legislation, and the conclusions at which they arrived were, I consider, the best that could have been laid down. They advised that applications should be encouraged tentatively by the granting of permissive bills, and this policy has given rise to the Electric Lighting Bill, 1882, promoted by Mr. Chamberlain, the President of the Board of Trade, regarding which much controversy has arisen. It could, indeed, hardly be expected that any act of legislation upon this subject could give universal satisfaction, because, while there are many believers in gas who would gladly oppose any measure likely to favor the progress of the rival illuminant, and others who wish to see it monopolized, either by local authorities or by large financial corporations, there are others again who would throw the doors open so wide as to enable almost all comers to interfere with the public thoroughfares, for the establishment of conducting wires without let or hindrance.

The law as now established takes, as I consider, a medium course between these diverging opinions, and, if properly interpreted, will protect, I believe, all legitimate interests, without impeding the healthy growth of establishments for the distribution of electric energy for lighting and for the transmission of power. Any firm or lighting company may, by application to the local authorities, obtain leave to place electric conductors below public thoroughfares, subject to such conditions as may be mutually agreed upon, the term of such license being limited to seven years; or an application may be made to the Board of Trade for a provisional order to the same effect, which, when sanctioned by Parliament, secures a right of occupation for 21 years. The license offers the advantage of cheapness, and may be regarded

as a purely tentative measure, to enable the firm or company to prove the value of their plant. If this is fairly established, the license would in all probability be affirmed, either by an engagement for its prolongation from time to time, or by a provisional order, which would, in that case be obtained by joint application of the contractor and the local authority. At the time of expiration of the provisional order, a right of pre-emption is accorded to the local authority, against which it has been objected with much force, by so competent an authority as Sir Frederick Bramwell, that the conditions of purchase laid down are not such as fairly to remunerate the contracting companies for their expenditure and risk, and that the power of purchase would inevitably induce the parochial bodies to become mere trading associations. But while admitting the undesirability of such a consummation, I cannot help thinking that it was necessary to put some term to contracts entered into with speculative bodies at a time when the true value of electric energy, and the best conditions under which it should be applied, are still very imperfectly understood. The supply of electric energy, particularly is a matter simply of commercial demand and supply, and which may therefore be safely left in the hands of individuals, or of local associations subject to a certain control for the protection of public interests. At the termination of the period of the provisional order, the contract may be renewed upon such terms and conditions as may at that time appear just and reasonable to Parliament, under whose authority the Board of Trade will be empowered to effect such renewal.

Complaints appear almost daily in the public papers, to the effect that townships refuse their assent to applications by electric light companies for provisional orders; but it may be surmised that many of these applications are of a more or less speculative character, the object being to secure monopolies for eventual use or sale, under which circumstances the authorities are clearly justified in withholding their assent; and no licenses or provisional orders should indeed be granted, I consider, unless the applicants can give assurance of being able and willing to carry out the work within a reasonable time. But there are technical questions involved which are not yet sufficiently well understood to admit of immediate operations upon a large scale.

Attention has been very properly called to the great divergence in the opinions expressed by scientific men regarding the area that each lighting district should comprise, the capital required to light such an area, and the amount of electric tension that should be allowed in the conductors. In the case of gas supply, the works are necessarily situated in the outskirts of the town, on account of the nuisance this manufacture occasions to the immediate neighborhood; and, therefore, gas supply must range over a large area. It would be possible, no doubt, to deal with electricity on a similar basis, to establish electrical mains in the shape of copper rods of great thickness, with branches diverging from them in all directions; but the question to be considered is, whether such an imitative course is desirable on account either of relative expense or of facility of working. My own opinion, based upon considerable practical experience and thought devoted to the subject, is decidedly adverse to such a plan. In my evidence before the Parliamentary Committee, I limited the desirable area of an electric district in densely populated towns to a quarter of a square mile, and estimated the cost of the necessary establishment of engines, dynamo-machines, and conductors, at £100,000, while other witnesses held that areas from one to four square miles could be worked advantageously from one center, and at a cost not materially exceeding the figure I had given. These discrepancies do not necessarily imply wide differences in the estimated cost of each machine or electric light, inasmuch as such estimates are necessarily based upon various assumptions regarding the number of houses and of public buildings comprised in such a district, and the amount of light to be apportioned to each, but I still maintain my preference for small districts.

By way of illustration, let us take the parish of St. James, near at hand, a district not more densely populated than other equal areas within the metropolis, although comprising, perhaps, a greater number of public buildings. Its population, according to the preliminary report of the census taken on the 4th April, 1881, was 29,865, it contains 3,018 inhabited houses, and its area is 784,000 square yards, or slightly above a quarter of a square mile.

To light a comfortable house of moderate dimensions in all its parts, to the exclusion of gas, oil, or candles, would require about 100 incandescence lights (or, if I may suggest a more euphonious expression, glow-lights) of from 15 to 18 candle power each, that being, for instance, the number of Swan lights employed by Sir William Thomson in lighting his house at Glasgow University. Eleven-horse power would be required to excite this number of incandescence lights, and at this rate the parish of St. James's would require $3{,}018 \times 11 = 33{,}200$-horse power to work it. It may be fairly objected, however, that there are many houses in the parish much below the standard here referred to, but, on the other hand, there are 600 of them with shops on the ground floor, involving larger requirements. Nor does this estimate provide for the large consumption of electric energy that would take place in lighting the eleven churches, eighteen club-houses, nine concert halls, three theaters, besides numerous hotels, restaurants, and lecture halls. A theater of moderate dimensions, such as the Savoy Theater, has been proved by experience to require 1,200 incandescence lights, representing an expenditure of 133-horse power; and about one-half that power would have to be set aside for each of the other public buildings here mentioned, constituting an aggregate of 2,926-horse power; nor does this general estimate comprise street-lighting, and to light the six and a-half miles of principal streets of the parish with electric light, would require, per mile, thirty-five arc lights of 350-candle power each, or a total of 227 lights. This, taken at the rate of 0.8-horse power per light, represents a further requirement of 182-horse power, making a total of 3,108-horse power, for purposes independent of house-lighting, being equivalent to one-horse power per inhabited house, and bringing the total requirements up to 109 lights = 12-horse power per house.

I do not, however, agree with those who expect that gas lighting will be entirely superseded, but have, on the contrary, always maintained that the electric light, while possessing great and peculiar advantages for lighting our principal rooms, halls, warehouses, etc., owing to its brilliancy, and more particularly to its non-interference with the healthful condition of the atmosphere, will leave ample room for the development of the former, which is susceptible of great improvement, and is likely to hold its own for the ordinary lighting up of our streets and dwellings.

Assuming, therefore, that the bulk of domestic lighting remains to the gas companies, and that the electric light is introduced into private houses, only at the rate of, say, twelve incandescence lights per house, the parish of St. James's would have to be provided with electric energy sufficient to work (9+12) 3,018 = 63,378 lights = 7,042-horse power effective; this is equal to about one-fourth the total lighting power required, taking into account that the total number of lights that have to be provided for a house are not all used at one and the same time. No allowance is made in this estimate for the transmission of power, which, in course of time, will form a very large application of electric energy; but considering that power will be mostly required in the day time, when light is not needed, a material increase in plant will not be necessary for that purpose.

In order to minimize the length and thickness of the electric conductor, it would be important to establish the source of power, as nearly as may be, in the center of the parish, and the position that suggests itself to my mind is that of Golden-square. If the unoccupied area of this square, representing 2,500 yards, was excavated to a depth of 25 feet, and then arched over so as to re-establish the present ground level, a suitable covered space would be provided for the boilers, engines and dynamo-machines, without causing obstruction or public annoyance; the only erection above the surface would be the chimney, which, if made monumental in form, might be placed in the center of the square, and be combined with shafts for ventilating the subterranean chamber, care being taken of course to avoid smoke by insuring perfect combustion of the fuel used. The cost of such a chamber, of engine power, and dynamo-machines, capable of converting that power into electric energy, I estimate at £140,000. To this expense would have to be added that of providing and laying the conductors, together with the switches, current regulators, and arrangements for testing the insulation of the wire.

The cost and dimensions of the conductors would depend upon their length and the electromotive force to be allowed. The latter would no doubt be limited by the authorities to the point at which contact of the two conductors with the human frame would not produce injurious results, or say to 200 volts, except for street lighting, for which purpose a higher tension is admissible. In considering the proper size of conductor to be used in any given installation, two principal factors have to be taken into account; first, the charge for interest and depreciation on the original cost of a unit of length of the conductor; and, secondly, the cost of the electrical energy lost through the resistance of a unit length. The sum of these two, which may be regarded as the cost of conveyance of electricity, is clearly least, as Sir William Thomson pointed out some time ago, when the two components are equal. This, then, is the principal on which the size of a conductor should be determined.

From the experience of large installations, I consider that electricity can, roughly speaking, be produced in London at a cost of about one shilling per 10,000 Ampere-Volts or Watts (746 Watts being equal to 1-horse power) for an hour. Hence, assuming that each set of four incandescence lamps in series (such as Swan's, but for which may be substituted a smaller number of higher resistance and higher luminosity) requires 200 volts electromotive force, and 60 Watts for their efficient working, the total current required for 64,000 such lights is 19,200 amperes, and the cost of the electric energy lost by this current in passing through one-hundredth of an ohm resistance, is £16 per hour.

The resistance of a copper bar one-quarter of a mile in length, and one square inch in section, is very nearly one-hundredth of an ohm, and the weight is about 2½ tons. Assuming, then, the price of insulated copper conductor at £90 per ton, and the rate of interest and depreciation at 7½ per cent., the charge per hour of the above conductor, when used eight hours per day, is 1½d. Hence, following the principle I have stated above, the proper

size of conductor to use for an installation of the magnitude I have supposed, would be one of 48.29 inches section, or a round rod eight inches in diameter.

If the mean distance of the lamps from the station be assumed as 350 yards, the weight of copper used in the complete system of conductors would be nearly 168 tons, and its cost £15,120. To this must be added the cost of iron pipes, for carrying the conductors underground, and of testing boxes, and labor in placing them. Four pipes, of 10 inches diameter each, would have to proceed in different directions from the central station, each containing 16 separate conductors of one inch diameter, and separately insulated, each of them supplying a sub-district of 1,000 lights. The total cost of establishing these conductors may be taken at £37,000, which brings up the total expenditure for central station and leads to £177,000. I assume the conductors to be placed underground, as I consider it quite inadmissible, both as regards permanency and public safety and convenience, to place them above ground, within the precincts of towns. With this expenditure, the parish of St. James's could be supplied with the electric light to the extent of about 25 per cent. of the total illuminating power required. To provide a larger percentage of electric energy would increase the cost of establishment proportionately; and that of conductors, nearly in the square ratio of the increase of the district, unless the loss of energy by resistance is allowed to augment instead.

It may surprise uninitiated persons to be told that to supply a single parish with electric energy necessitates copper conductors of a collective area equal to a rod of eight inches in diameter; and how, it may be asked, will it be possible under such conditions to transmit the energy of waterfalls to distances of 20 or 30 miles, as has been suggested. It must indeed be admitted that the transmission of electric energy of such potential (200 volts) as is admissible in private dwellings would involve conductors of impracticable dimensions, and in order to transmit electrical energy to such distances, it is necessary to resort in the first place to an electric current of high tension. By increasing the tension from 200 to 1,200 volts the conductors may be reduced to one-sixth their area, and if we are content to lose a larger proportion of the energy obtained chiefly from a waterfall, we may effect a still greater reduction. A current of such high potential could not be introduced into houses for lighting purposes, but it could be passed through the coils of a secondary dynamo-machine, to give motion to another primary machine, producing currents of low potential to be distributed for general consumption. Or secondary batteries may be used to effect the conversion of currents of high into those of low potential, whichever means may be found the cheaper in first cost, in maintenance, and most economical of energy. It may be advisable to have several such relays of energy for great distances, the result of which would be a reduction of the size and cost of conductor at the expense of final effect, and the policy of the electrical engineer will, in such cases, have to be governed by the relative cost of the conductor, and of the power at its original source. If secondary batteries should become more permanent in their action than they are at the present time, they may be largely resorted to by consumers, to receive a charge of electrical energy during the daytime, or the small hours of the night, when the central engine would otherwise be unemployed, and the advantage of resorting to these means will depend upon the relative first cost, and cost of working the secondary battery and the engine respectively. These questions are however, outside the range of our present consideration.

The large aggregate of dwellings comprising the metropolis of London covers about seventy square miles, thirty of which may be taken to consist of parks, squares, and sparsely inhabited areas which are not to be considered for our present purpose. The remaining forty square miles could be divided say into 140 districts, slightly exceeding a quarter of a square mile on the average, but containing each fully 3,000 houses, and a population similar to that of St. James's.

Assuming twenty of these districts to rank with the Parish of St. James's (after deducting the 600 shops which I did not include in my estimate) as central districts, and sixty to be comparatively poor neighborhoods, and estimating the illuminating power required for these three classes in the proportion of 1 to ⅔ to ⅓, we should find that the total capital expenditure for supplying the metropolis with electric energy to the extent of 25 per cent. of the total lighting requirements would be—

$$\begin{aligned} 20 \times \quad 177{,}000 &= £3{,}540{,}000 \\ 60 \times \tfrac{2}{3} \times 177{,}000 &= £7{,}080{,}000 \\ 60 \times \tfrac{1}{3} \times 177{,}000 &= £3{,}540{,}000 \\ \hline & £14{,}160{,}000 \end{aligned}$$

or say £14,000,000, without including lamps and internal fittings, and making an average capital expenditure of £100,000 per district.

To extend the same system over the towns of Great Britain and Ireland would absorb a capital exceeding £64,000,000, to which must be added, for lamps and internal fittings, £16,000,000, making a total capital expenditure of £80,000,000. Some of us may live to see this realized, but to find such an amount of capital, and, what is more important, to find the manufacturing appliances to produce work representing this value of machinery and wire, must necessarily be the result of many years of technical development. If, therefore, we see that electric companies apply for provisional orders to supply electric energy, not only for every town throughout the country, but for colonies and for foreign parts, we are forced to the conclusion that their ambition is somewhat in excess of their power of performance; and that no provisional order should be granted except conditionally on the work being executed within a reasonable time, as without such a provision the powers granted may have the effect of retarding instead of advancing electric lighting, and of providing an undue encouragement to purely speculative operations.

The extension of a district beyond the quarter of a square mile limit, would necessitate an establishment of unwieldy dimensions, and the total cost of electric conductors per unit area would be materially increased; but independently of the consideration of cost, great public inconvenience would arise in consequence of the number and dimensions of the electric conductors, which could no longer be accommodated in narrow channels placed below the curb stones, but would necessitate the construction of costly subways—veritable *cava electrica*.

The amount of the working charges of an establishment comprising the parish of St. James's would depend on the number of working hours in the day, and on the price of fuel per ton. Assuming the 64,000 lights to incandesce for six hours a day, the price of coal to be 20s. a ton, and the consumption two lbs. per effective horse power per hour, the annual charge under this head, taking 8 hours' firing, would amount to about £18,300, to which would have to be added for wages, repairs, and sundries, about £6,000; for interest, with depreciation at 7½ per cent., £13,300; and for general management say, £3,400; making a total annual charge of £41,000, or at the rate of 12s. 9½d. per incandescence lamp per annum. To this must be added the cost of the renewal of lamps, which may be taken at 5s. per lamp of 16 candles, lasting 1,200 hours, or to 9s. per annum, making a total of 21s. 9½d. per lamp for a year.

In comparing these results with the cost of gas lighting, we shall find that it takes five cubic feet of gas, in a good argand burner, to produce the same luminous effect, as one incandescence light of 16 candle power. In lighting such a burner every day, for six hours on the average, we obtain an annual gas consumption of 10,950 cubic feet, the value of which, taken at the rate of 2s. 8d. per thousand, represents an annual charge of 29s., showing that electric light by incandescence, when carried out on a large scale, is decidedly cheaper than gas lighting at present prices, and with the ordinary gas burners.

On the other hand, the cost of establishing gas works and mains of a capacity equal to 64,000 argand burners would involve an expenditure not exceeding £80,000 as compared with £177,000 in the case of electricity; and it is thus shown that, although it is more costly to establish a given supply of illuminating power by electricity than gas, the former has the advantage as regards current cost of production.

It would not be safe, however, for the advocates of electric lighting to rely upon these figures as representing a permanent state of things. In calculating the cost of electric light, I have only allowed for depreciation and 5 per cent. interest upon capital expenditure, whereas gas companies are in the habit of dividing large dividends, and can afford to supply gas at a cheaper rate, by taking advantage of recent improvements in manufacturing operations, and of the ever-increasing value of their bye-products, including tar, coke, and ammoniacal liquor. Burners have, moreover, been recently devised by which the luminous effect for a given expenditure of gas can be nearly doubled by purely mechanical arrangements, and the brilliancy of the light can be greatly improved.

On the other hand, electric lighting also may certainly be cheapened by resorting, to a greater extent than has been assumed, to arc lighting, which, though less agreeable than the incandescence (or glow) light for domestic purposes, can be produced at less than half the cost, and deserves on that account the preference for street lighting, and for large halls, in combination with incandescence lights. Lamps by incandescence may be produced hereafter at a lower cost, and of a more enduring character.

Considering the increasing public demand for improved illumination, it is not unreasonable to expect that the introduction of the electric light to the full extent here contemplated, would go hand-in-hand with an increasing consumption of gas for illuminating and heating purposes, and the neck-to-neck competition between the representatives of the two systems of illumination which is likely to ensue, cannot fail to improve the quality, and to cheapen the supply of both, a competition which the consuming public can afford to watch with complacent self-satisfaction. Electricity must win the day as the light of luxury; but gas will, at the same time, find an ever-increasing application for the more humble purposes of diffusing light.

In my address to the British Association I dwelt upon the capabilities and prospects of gas, both as an illuminant and as a heating agent, and I do not

think that I was over-sanguine in predicting for this combustible a future exceeding all present anticipations.

I showed that if specially supplied for the purpose it would become not only the most convenient but by far the cheapest form of fuel that can be delivered to our towns. Such a general supply of heating separately from illuminating gas, by collecting the two gases into separate holders during the process of distillation, would have the beneficial effects—

1st. Of giving to lighting gas a higher illuminating power.

2d. Of relieving our towns of their most objectionable traffic—that in coal and ashes.

3d. Of effecting the perfect cure of that bugbear of our winter existence—the smoke nuisance.

4th. Of largely increasing the production of those valuable bye-products, tar, coke and ammonia, the annual value of which already exceeds by nearly £3,000,000 that of the coal consumed in the gas works.

The late exhibitions have been beneficial in arousing public interest in favor of smoke abatement, and it is satisfactory to find that many persons, without being compelled to do so, are now introducing perfectly smokeless arrangements for their domestic and kitchen fires.

The Society of Arts, which for more than 100 years has given its attention to important questions regarding public health, comfort and instruction would, in my opinion, be the proper body to examine thoroughly into the question of the supply and economical application of gas and electricity for the purposes of lighting, of power production, and of heating. They would thus pave the way to such legislative reform as may be necessary to facilitate the introduction of a rational system.

If I can be instrumental in engaging the interest of the Society in these important questions, especially that of smoke prevention, I shall vacate this chair next year with the pleasing consciousness that my term of office has not been devoid of a practical result.

The New East End Works of the Cincinnati Gas Light and Coke Company.

The plot of ground upon which these works are to stand is situated on the Ohio river, about 3½ miles northeast of the suspension bridge. It has a frontage of 408 feet on the river, and runs back about 600 ft., between Main and Spencer streets, to Eastern avenue. The main buildings, comprising the condenser, scrubber, exhauster, meter, governor, storehouses and lime-houses front on Eastern avenue; while the wings for purifying houses extend back on Main and Spencer streets, 110 feet. Immediately south of these wings, on either side of the lot, are located the blacksmith and machine shops. Within the space thus enclosed are situated two holder-tanks, each 126 ft. in diameter by 31 ft. in depth. South of these, and across the lot, is located the retort house, especially planned for the use of the "Ross Steam Stokers." The first, or basement, story will be 10 ft. in height, of "rock-worked" Ohio River blue limestone; the second story, or retort house proper, with the towers, etc., will be of brick. In the towers at each end are located the "stables" for the reserve stokers, two pairs of which will at all times be kept ready to take the place of machines temporarily disabled. In the basement will be located the railway for removing the coke, and around the house, above the level of the retort-stacks, will run the railway on which coal is delivered to the bins, and thence run into the hoppers of the charging machines. South of the retort house, and on either side, extending back toward the river are located the hydraulic elevators and coke-bins, in which the surplus coke is stored ready for delivery into carts, etc. Between these bins will be located the coal sheds, and in the center of the lot, south of the sheds, will be the river elevators buildings, and thence down the bank to low water runs the inclined elevator, upon which the coal is brought up and deposited in sheds. The retort house will contain 56 benches of "eights," or 448 retorts—with a working capacity of three millions feet per day.

Correspondence

[The JOURNAL is not responsible for the opinions expressed by correspondents.]

The Future of the Gas Business.

NEW YORK, Dec. 12, 1882.

To the Editor AMERICAN GAS LIGHT JOURNAL:

In my former communication I referred to that particular class of people who have the most complaints to make against gas companies. As an illustration of the absurdity of some of the complaints of these grumblers, I will repeat the conversation which I heard in a gas office a few years ago. A man stepped into the office to pay a gas bill. He looked nervous and fretful. His careworn face exhibited signs and evidence of having been in some sort of trouble for a long time, for it was unmistakably visible in every lineament of his countenance. He evidently thought almost everything in this world was going wrong, and he appeared to be in a state of chronic dissatisfaction with himself and everything around him. He approached the cashier's desk, laid his bill down, and remarked—

"Why is it that you charge a higher price for gas here than they do in other cities?"

"Why, there are several reasons," responded the cashier, and continued, "You speak of other cities; what places do you refer to?"

"Well; Boston, New York, Philadelphia, and lots of other places."

Said the cashier, "Do you know what the price is in Boston?"

"No," answered the grumbler.

"Well; do you know what it is in New York?"

"No; I don't know; but everybody says you charge more here than they do in the other cities."

"Yes; but how about Philadelphia; do you know what the price is there?"

"No," said he, "but everybody says you charge more here than they do anywhere else; and what everybody says must be true."

"Now," said the cashier, "my friend, you don't seem to know much about the price of gas in the places you have mentioned. Do you know what the price is here?" Involuntarily, he felt in his pocket for the bill to look at it, and see what price he had just paid. The cashier, continuing, said—

"I want to tell you that yours is a fair specimen of the complaints that I stand here and listen to every day. You complain of the price of gas here, as compared with that in Boston, New York, Philadelphia, and other places. You not only do not know what the price is in those cities you have mentioned, but you do not even know the price you have just paid here." The grumbler waited to hear no more.

Again, a gentleman bought a few shares of gas stock; and when the time arrived to collect his dividend he was surprised to find that it was only at the rate of eight per cent.

"Why," he exclaimed, "I thought you paid *forty* per cent.; everybody said so, and I thought I had struck a good thing when I bought this stock; but if you don't pay more than eight per cent. I shall sell out, and put the money into mining stock where it will pay something."

These are specimens of the complaints of the *public* who are dissatisfied, and whom Mr. Pratt seems to think should step in and have control of the gas business, because they are not satisfied with the manner in which the representative business men of this country manage it; for does not Mr. Pratt very well know that it is generally the fact that the directors and principal stockholders of gas companies, in most cities, are representative men—men in whom the people who know them have confidence—men who are identified with the prosperity and best interests of the cities where they live; and they know and realize that it is better, for even their own selfish interest, to deal fairly, squarely, and even generously with the people.

He speaks about the "great privileges" which the gas companies have; about the "right of eminent domain" of railroad companies, etc. What gas company has the "right of eminent domain" or the right to take any man's house and lands, and pay for the same a price which a jury may award?

He says the gas company has given it the right to *invade* every street and highway with its mains and supplies, whenever it pleases—as if it were a great privilege, and benefited the gas company alone, and could be used for other purposes than simply to convey the gas to supply the public and private consumers along the street where it is laid. Can it be used to transport millions of dollars worth of merchandise, passengers, etc., from one end of the country to the other, or to foreign lands? Does not Mr. Pratt know that every gas company has mains laid in many streets which benefit only the consumer, and bring no return to the gas company?

Again, he says, "In a large majority of cases it is given the monopoly of the business." Is Mr. Pratt quite sure he is right in that statement? Where is the company in this country that has a monopoly of the business secure from the threats of an opposition company at any moment? It is possible that there may be municipal officers in a very few cities having the good judgment to foresee and realize the effects of competing gas companies—which are generally the operations of speculators working under the pretence of benefiting the public by selling "cheap gas"—and protecting themselves and their gas companies from the disastrous consequences of having to pay a price for gas sufficient to cover the interest on two or more capitals, by keeping rival or speculating concerns out, and thus secure their gas at reasonable rates, and at the same time fair dividends to the stockholders of the gas companies; but these instances are few.

One not entirely familiar with the business would suppose from Mr. Pratt's views, that opposition gas companies were started because gas companies charge too high a price for gas, or make too much money; but such supposition is not in accordance with the facts. Opposition gas companies are rarely started by the citizens of any place. As I said before, they are the work of speculators and persons who have some wonderful patent right to sell which—if they can sell to the gas company at a round price, very well; if not, they threaten an opposition gas company, and gull the people by telling them they can make a much better gas than the old company, and at a very much less cost, and more than one gas company has been nearly ruined by trying the experiment.

MANAGER.

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SATURDAY, DECEMBER 16, 1882.

Patents.

265,222. Registering gas consumption and manufacturing to a standard.—H. H. Edgerton.
265,423. Method of operating gas engines in torpedo boats.—E. W. Kellogg.
265,433. Gas burner.—J. W. Plunkett.
265,493. Liquid carbonic acid gas motor.—A. Gateau.
265,585. Gas compressing pump.—W. W. Doolittle.
265,792. Process of and apparatus for manufacturing gas.—T. B. Fogarty.
265,793. Process of manufacturing gas.—T. B. Fogarty.
265,915. Process of and apparatus for manufacturing hydrogen gas.—W. H. Bradley.
266,210. Shield for protecting taper flame of gas burners.—W. D. Schooley.
266,304. Gas engine.—Peter Munzinger.
266,326. Process of and apparatus for making coal gas.—A. Stamm.
266,540. Gas burner gauge.—D. M. Small.
266,541. " " " "
266,542. " " " "
266,543. Gas test and pressure gauge.—D. M. Small.
266,631. Combined gas and oil burner.—J. H. Kidder.
266,634. Gas burner.—J. G. Miller.
266,676. Gas burner.—S. Cook and J. H. Piper.
266,888. Gas burner.—E. B. Requa.
266,889. " " "
266,890. " " "
267,458. Electrical lighting device for gas engines.—A. K. Rider.
267,466. Attachment to burners for gas, etc.—I. W. Shaler.
267,933. Apparatus for manufacturing wood gas. G. Ramsdell.
267,971. Apparatus for burning gas.—G. H. Burrows.
268,096. Gas retort furnace.—H. C. Hann.
268,251. Wet gas meter.—W. Mackintosh.
268,368. Gas regulator.—G. S. Lacey.

Trying to Get their Money Back.

In their "City Notes" last Friday the *Pall Mall Gazette* said: "It seems that the fight among electric light companies is about to begin in earnest. Individual shareholders in the companies created for the purpose of buying 'patent rights' from this or that so-called parent company have already begun to issue writs with a view to obtain the refunding of their money; and it is now stated that the directors of a number of the subsidiary companies are about to take combined action for the same purpose. This will surprise no one familiar with the extraordinary proceedings attendant upon the creation of these companies, and it is possible that the exposures consequent upon a thoroughly good fight in the law courts may do much to check similar abuses in the future. That, however, is a doubtful point; and, after all, it is not possible to feel any deep commiseration for those who allowed themselves to be taken in. Few of them believed the statements of the prospectuses issued. They thought, however, that others might believe, and took shares in the hope of selling again at a premium. Not succeeding in doing so, they now demand their money back. A few, of course, did get caught up in the wave of mock enthusiasm about electric lighting, and for their sakes, as well as for the wholesomeness of the lesson, we hope the schemers will be made to disgorge; but there is not much room, on the whole, for moralizing over the fate of one set of rogues more than another."

GAS TROUBLES IN QUINCY, ILLS.—The City Council being unable to pay the bill of the gas company, the company stopped the supply of gas. Cause, no money in the city treasury.

Gas Stocks.

Quotations by G. W. Close Jr., Broker and Dealer in Gas Stocks.
(with W. B. Scott & Co.,)
34 PINE STREET, NEW YORK CITY.

DECEMBER 16, 1882.

☞ All communciations will receive particular attention
☞ The following quotations are based on the par value of $100 per share.

	Capital.	*Par.*	*Bid.*	*Asked*
Gas Co.'s of N. Y. City.				
Central	$466,000	50	75	85
Harlem	1,800,000	50	90	95
" Bonds	170,000			103
Manhattan	4,000,000	50	212	218
Metropolitan	2,500,000	100	178	182
" Bonds	658,000	..	106	108
Mutual	3,500,000	100	103	106
" Bonds	1,500,000		100	102
Municipal	1,500,000	100	165	170
" Bonds	750,000		106	110
New York	4,000,000	100	110	115
Northern	270,000	50	90	—
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	108	112
Citizens	1,200,000	20	67	70
" S. F. Bonds.	320,000	1000	105	107
Fulton Municipal	3,600,000	100	70	80
Peoples	1,000,000	10	40	45
" Bonds	290,000	.	104	107
" "	250,000	...	88	90
Metropolitan	1,000,000	100	67	70
Nassau	1,000,000	25	50	55
" Ctfs.	700,000	1000	90	93
Williamsburgh	1,000,000	50	50	55
" Bonds	1,000,000	...	100	101
Richmond Co., S. I.	300,000	50	70	75
" Bonds	40,000	—	—	—
Out of Town Gas Companies.				
Buffalo Mutual, N.Y	750,000	100	72	75
" Bonds	200,000	1000	95	100
Citizens, Newark	918,000	50	—	—
" " Bds.	124,000	—	105	10
Chicago Gas Co., Ills			150	155
Cincinnati G. & C. Co.			178	180
Consolidated, Balt.			42	43
Bonds			107	—
East Boston, Mass	220,000	25	122	128
Hannibal, Mo	100,000	100	95	100
Hartford, Conn	700,000	25	120	128
Halifax N. S.	400,000	40	148	150
Hamilton, Ontario	150,000	40	117½	
Jersey City	750,000	20	155	160
Jacksonville, Ill	120,000	50	100	...
Lewistown Maine	400,000	100	—	100
Laclede St Louis Mo.	1,200,000	100	117	—
Montreal, Canada	2,000,000	100	186	187
New Haven, Conn		25	144	—
Oakland, Cal.			32	33
Peoples, Jersey City		...	75	80
" " Bds.			...	...
Pittsfield, Mass			120	130
Rochester, N. Y.		50	70	80
Wilmington, Del.		50	174	...
Yonkers		50	30	32
St. Louis Missouri	600,000	50	250	254
San Francisco Gas-Co., S. Fr'isco Cal.			55	57
Toledo, Ohio			95	97
Troy, Citizens	600,000	100	—	—
Washington, D. C.	1,500,000	20	215	220
" Scrip	375,000	15	245	250

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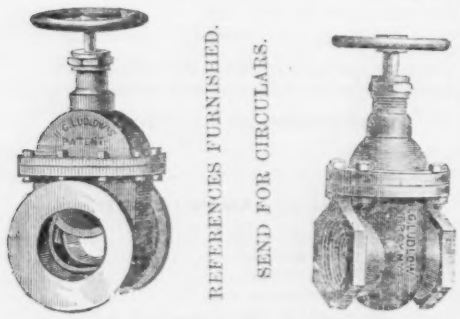

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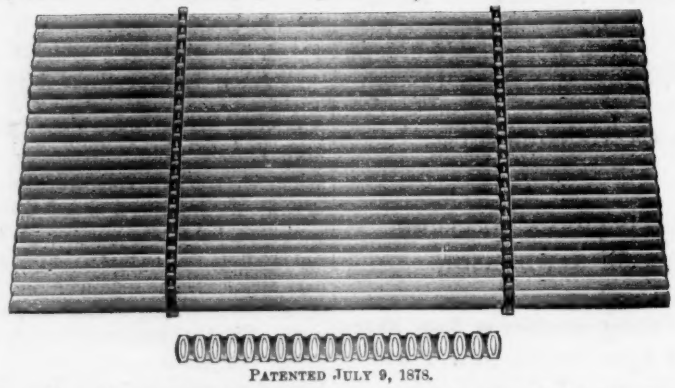

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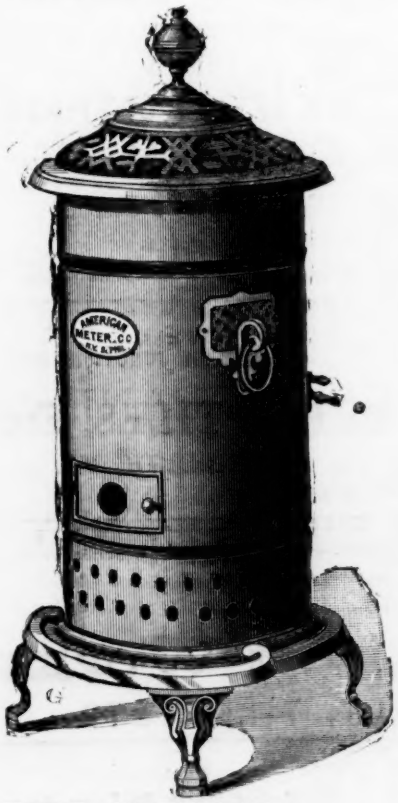

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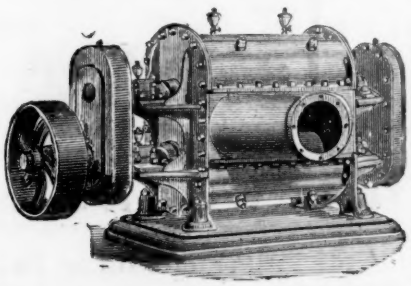

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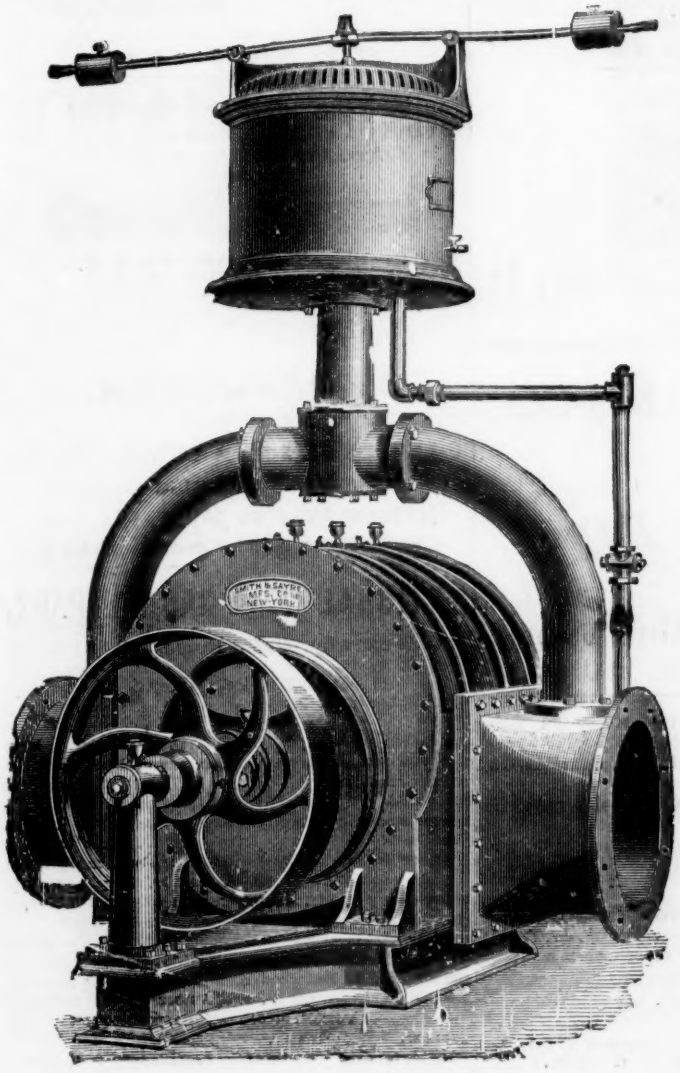

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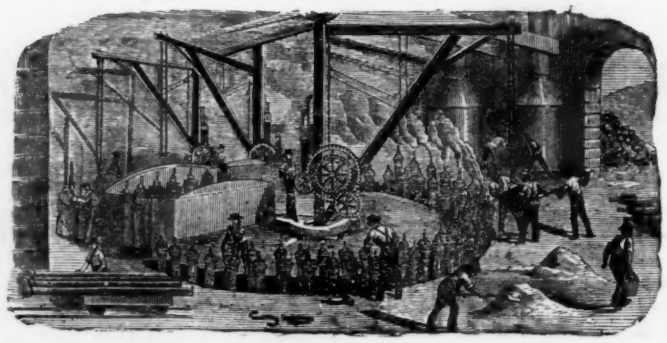

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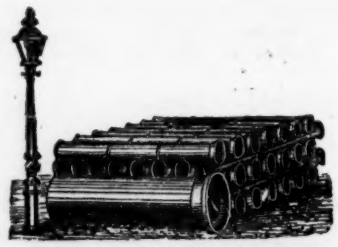

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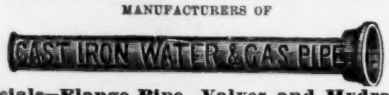

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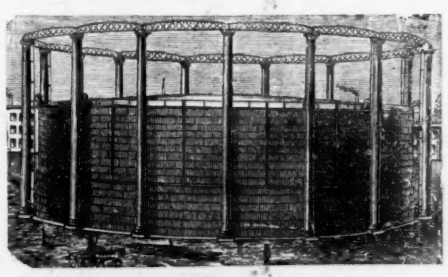

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Amsterdam Company (two)	3,000,000
Aldershot Company	200,000
ALLEGHENY COMPANY, U. S. A	1,000,000
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Balmaine Company, N. S. W	125,000
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Birkenhead Corporation	2,500,000
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Bradford Corporation	6,750,000
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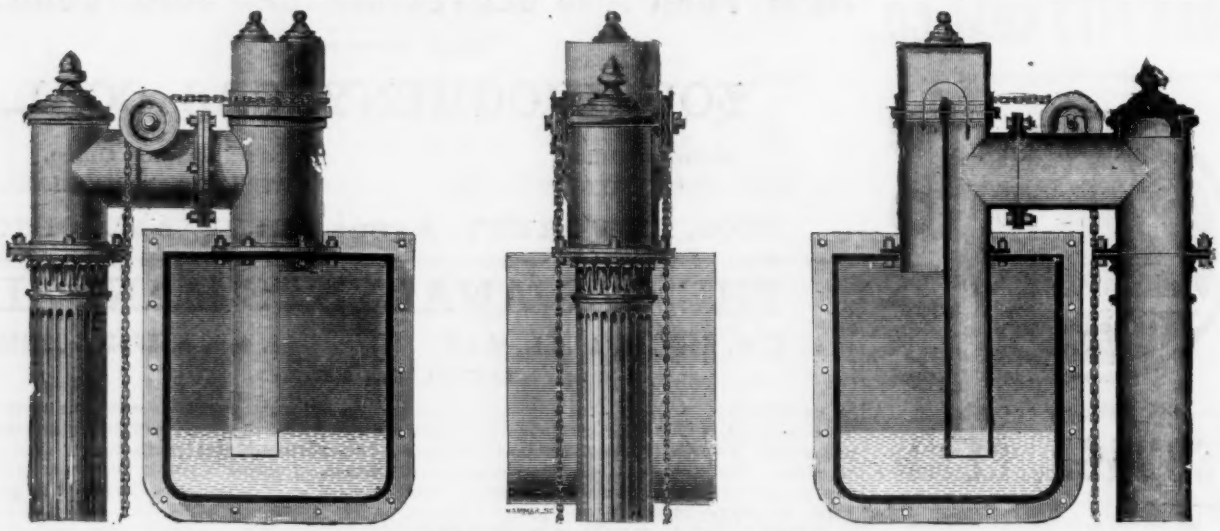

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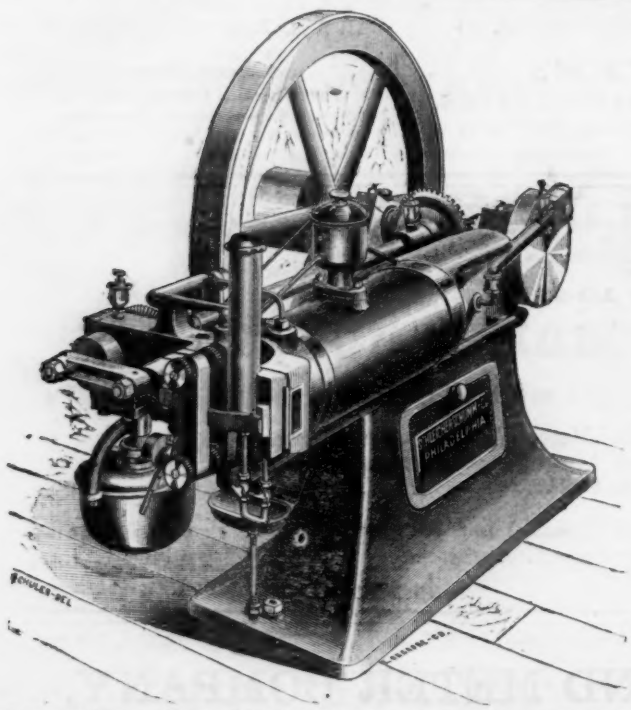

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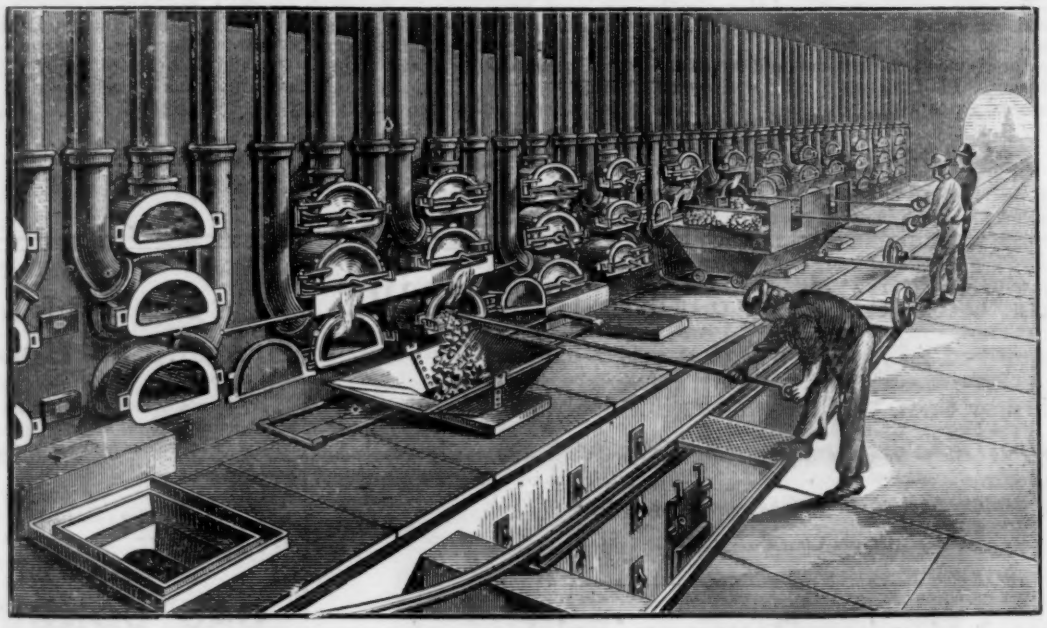

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